FINAL REPORT

VOLUME I

EXECUTIVE SUMMARY

FOR

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

AND

MODERNIZATION PROGRAM CENTRAL BOILER PLANT (INCREMENT E MOD.)

LONGHORN ARMY AMMUNITION PLANT, TEXAS
(LHAAP)

U.S. ARMY ENGINEER DISTRICT–FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

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OKLAHOMA CITY, OKLAHOMA 73106

CONTRACT No. DACA 63-81-C-0132

MAY 1984

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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FINAL REPORT

FOR

ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

INCLUDING

MODERNIZATION OF CENTRAL BOILER PLANT

LONGHORN ARMY AMMUNITION PLANT, TEXAS

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ENERGY ENGINEERING ANALYSIS PROGRAM

1.0 INTRODUCTION

1.1 GENERAL

1.1.1 Contract Authority. Contract No. DACA63-81-C-0132, dated 1 July, 1981, between the Department of the Army, Corps of Engineers, Fort Worth District, and Carnahan-Thompson-Delano, Inc., provides for the engineering services of the Energy Engineering Analysis Program (EEAP) for Longhorn Army Ammunition Plant, Marshall, Texas.

1.2 PURPOSE

1.2.1 The purpose of this report is to provide the Army with data of conservation projects associated with the investigation of facilities; to analyze present fuel consumption records; and to develope an orderly procedure for reducing energy consumption consistent with Army Facilities Energy Plan (AFEP), dated 26 October, 1981.

1.3 LHAAP FACILITY

1.3.1 Longhorn Army Ammunition Plant is located 15 miles northeast of Marshall, Texas, and 25 miles northwest of Shreveport, Louisiana. Its 13 square miles are bounded on the north by Big Cypress Bayou of Caddo Lake.

1.3.2 Since 1952 Longhorn Army Ammunition Plant has been a GOCO Facility and Thiokol, Corp. is the Contractor operating, maintaining and managing the Plant. The Plant presently produces pyrotechnic and illuminating devices.

1.3.3 For several years Thiokol Corp. has implemented Energy Conservation measures for the Longhorn Plant and as a result has substantially reduced energy and costs through-out the Base, mainly through their operations. A number of completed in-house projects has saved an estimated 34,027 MBTU/Yr in fossile energy since base year 1975. Thiokol has won awards for their participation in energy conservation efforts.

1.3.4 Requirements for producing ammunition at LHAAP are low. Many production facilities are used infrequently, sometimes for a few weeks out of the year, before operations are shut down and personnel shifted to another location for other production operations.

1.4 ENERGY SIMULATION

1.4.1 Energy usage of individual buildings was modeled using the Facility Engineering Analysis Program (FEAP) developed by Carnahan-Thompson-Delano, Inc. The program was for single zone applications and incorporates building construction and orientation, occupancy schedules ventilation data and equipment classifications to determine the yearly energy consumption for each building.

1.4.2 The driver program for FEAP was (FALCON) Fast Load Calculation. FALCON uses ASHRAE heat transfer functions to compute energy flow through walls, floors, doors, windows and roofs. Appropriate Cooling Load Temperature Differences (CLTD) and Cooling Load Factors were selected to account for the building mass. Infiltration was determined using the ASHRAE "crack method". Solar heat gain was calculated using ASHRAE Solar Heat Gain Factors (SHGF).

1.4.3 FEAP uses the FALCON data to compute building envelope heat transfer per degree temperature difference between interior and exterior per hour (BTU/F x H).

1.4.4 Hourly interior and exterior temperature differentials are used to compute the building heat loss or gain. Interior temperatures for each building were adjusted for each of the occupancy modes (Heating-Occupied, Heating-Unoccupied, Cooling-Occupied). Exterior, or ambient, temperatures were obtained from National Oceanic and Atmospheric Administration Environmental Data Information Service for Shreveport, LA.

2.0 EXISTING ENERGY CONSUMPTION

2.1 BASEWIDE ENERGY CONSUMPTION

2.1.1 The two existing, major sources of energy analyzed at LHAAP are Electricity and Natural Gas during the Study year FY-81. Fuel Oil #2 usage during this period was less than 1% of the total energy consumed, and for this reason is not considered. Consumption shown in Table 4.1 is in Site (or Metered) MBTU/YR.

2.1.2 Basewide energy consumption was categorized into fuel usage. These categories are listed as follows and summarized in TABLE 4.1.

PROCESS
BUILDING STEAM - CENTRAL PLANTS
STEAM DISTRIBUTION SYSTEM
BUILDING ENERGY
ELECTRICAL MOTORS
ELECTRICAL LOSSES
FEEDER #7
STREET LIGHTING
UNACCOUNTED ENERGY

2.1.3 **PROCESS** consists of data obtained from FEAP output. Electrical process MBTU/YR is the total production MBTU/YR converted from KWH/YR for the Base. Estimated steam usage for production processes on the Base are totaled and then converted to MBTU/YR of fuel. Refer to Section J, Volume VI for documentation.

2.1.4 **BUILDING STEAM - CENTRAL PLANTS** is the calculated energy values for heating buildings that are connected to their respective boiler steam distribution network. The boilers for these networks are located in Bldg 401, Bldg 703-C, and Bldg 812. The steam energy is converted to fuel energy. The reduction in fuel usage in FY-81 from that in FY-75 is due largely to the boiler heat recovery equipment that was added to Central Plant Bldg #401. Refer to Section J, Volume VI for documentation.

2.1.5 **STEAM DISTRIBUTION SYSTEM** is the sum of calculated steam loss through piping and traps. Steam energy is converted to fuel energy. Refer to Section J, Volume VI for documentation.

2.1.6 **BUILDING ENERGY** consists of data calculated by the computer program, FEAP. This data is the sum of electrical energy usage for buildings on the Base for Lighting, Miscellaneous, building heating and hot water heating; plus the sum of natural gas usage for building heating, hot water heating and food service. The data was obtained from FEAP output and is documented in Section J, Volume VI.

2.1.7 **ELECTRICAL MOTORS** is the summary of the electrical energy consumption of A/C MOTORS and PUMP STATION (FEEDER #8).

2.1.7.1 A/C MOTORS is a calculated value of air conditioning motor loads from field observations and cooling loads calculated by FEAP. Refer to Section J, Volume VI for documentation.

2.1.7.2 PUMP STATION (FEEDER #8) is the estimated electrical energy consumed by pumps located in River Pump House, Building 414. This information is based on field survey data. Refer to Section J, Volume VI for documentation.

2.1.8 **ELECTRICAL LOSSES** is the summary of the electrical energy for TRANSFORMER loss and DISTRIBUTION loss.

2.1.8.1 TRANSFORMER loss consists of data calculated from information gathered from field observations. Refer to Section J, Volume VI for documentation.

2.1.8.2 DISTRIBUTION loss consists of data for electrical distribution line losses calculated for the Base from information gathered from field observations. Refer to Section J, Volume VI for documentation.

2.1.9 **FEEDER #7** is metered quantity of electrical energy used by Feeder #7 of the main distribution service. Refer to Section J, Volume VI for documentation.

2.1.10 **STREET LIGHTING** consists of data calculated from information gathered from field observations. Refer to Section J, Volume VI for documentation.

2.1.11 **UNACCOUNTED ENERGY** is the difference between the sum of all above items and that metered. For most part, the miscellaneous electrical usage can be attributed to construction of new production area #25 during the FY-81 period. The area includes a 400 ton chiller, cooling tower, and pumps that were operating, intermittently, during the latter part of FY-81. An estimated 250,000 to 300,000 KWH could have been used in this area. The remaining KWH can be credited towards inconsistency of operating the Base and the varying production times. Some of the miscellaneous natural gas energy can also be attributed to construction of the new production area #25 during FY-81. Several buildings in this area were utilizing steam during the latter part of FY-81, based on field observations. It is not possible to estimate, with any degree of accuracy, the amount of steam energy used in area #25. The remaining miscellaneous energy load can be credited towards inconsistency of heating of buildings on the Base and possible lower efficiencies of the gas-fired equipment than that used as a basis of study.

2.1.12 Base Year FY-75 Energy also includes the two existing sources of Natural Gas and Electricity. However, a substantial amount of Fuel Oil #2 was used during this period. Energy consumption has been catagorized similarly to that shown for FY-81, and is shown in Table 4.2. Consumption shown is in Site (or metered) MBTU/yr.

2.1.13 Figure 1 is a "pie" chart of Table 1.

2.1.14 Figure 2 is a "pie" chart of Table 2.

TABLE 1

BASEWIDE

SUMMARY OF ENERGY USAGE (SITE)

FY-81

DESCRIPTION	ELECTRICITY (MBTU/YR)	NATURAL GAS (MBTU/YR)	TOTAL (MBTU/YR)
PROCESS:	18,689	156,960	175,649
BLDG STM - CENTRAL PLANTS:			
CENTRAL PLANT #401	------	122,869	
CENTRAL PLANT #703-C	------	6,592	
CENTRAL PLANT #812	------	2,261	
SUBTOTAL:		131,722	131,722
STEAM DISTRIBUTION SYSTEM:	------	86,000	86,000
BUILDING ENERGY:	3,906	7,639	11,545
ELECTRICAL MOTORS:			
A/C MOTORS	3,386	------	
PUMP STATION-FEEDER #8	506	------	
SUBTOTAL:	3,892	------	3,892
ELECTRICAL LOSSES:			
TRANSFORMER	2,434	------	
DISTRIBUTION	202	------	
SUBTOTAL:	2,636	------	2,636
FEEDER #7:	1,012	------	1,012
STREET LIGHTING:	118	------	118
UNACCOUNTED ENERGY: *1	4,692	38,206	42,898
TOTAL	34,945	420,527	455,472
METERED	34,945	420,527	455,472

*1 Includes part time activity of Area #25 and miscellaneous operating savings by LHAAP.

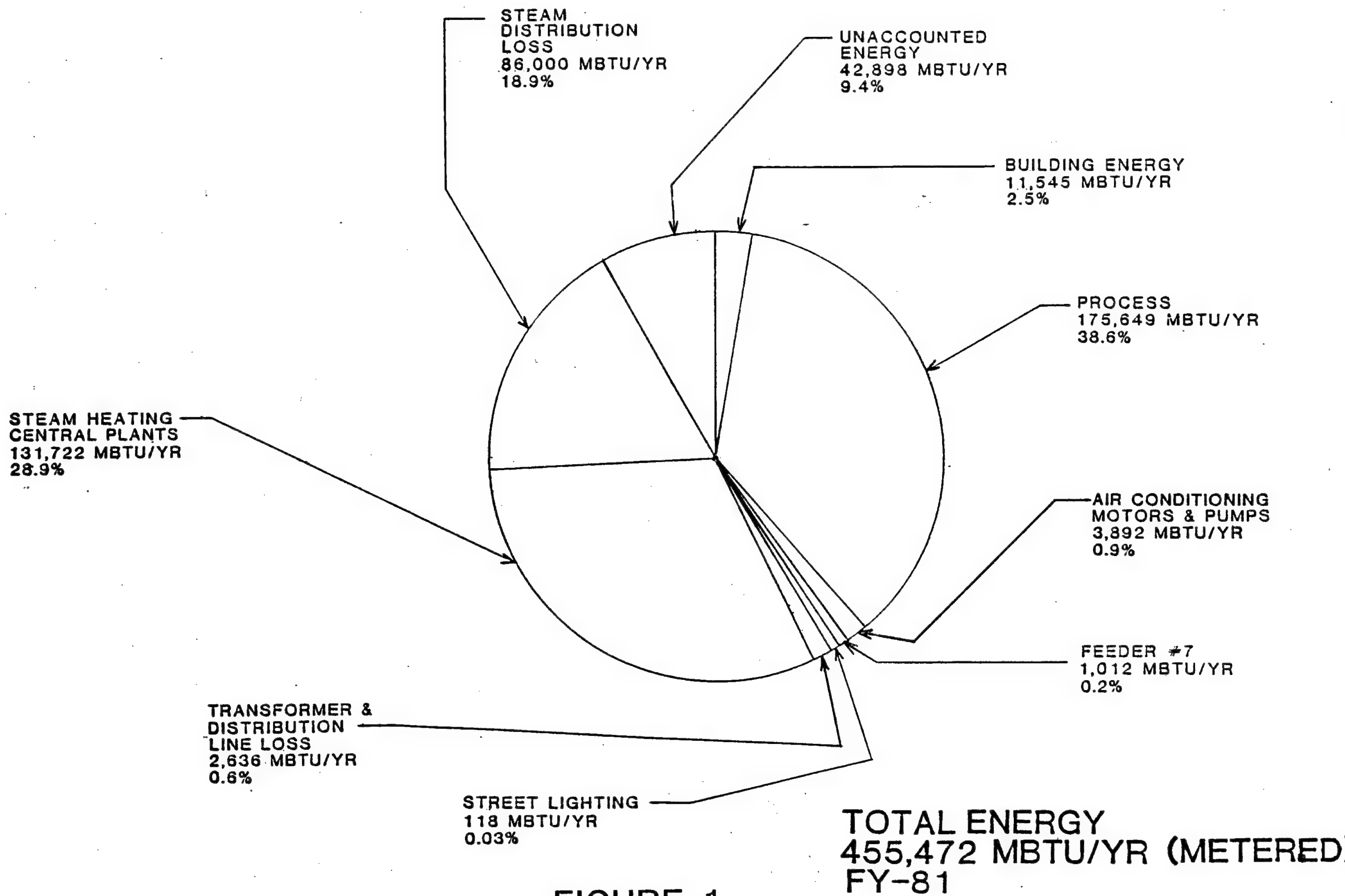

STEAM
DISTRIBUTION
LOSS
86,000 MBTU/YR
18.9%
UNACCOUNTED
ENERGY
42,898 MBTU/YR
9.4%
BUILDING ENERGY
11,545 MBTU/YR
2.5%
PROCESS
175,649 MBTU/YR
38.6%
STEAM HEATING
CENTRAL PLANTS
131,722 MBTU/YR
28.9%
AIR CONDITIONING
MOTORS & PUMPS
3,892 MBTU/YR
0.9%
FEEDER #7
1,012 MBTU/YR
0.2%
TRANSFORMER &
DISTRIBUTION
LINE LOSS
2,636 MBTU/YR
0.6%
STREET LIGHTING
118 MBTU/YR
0.03%
TOTAL ENERGY
455,472 MBTU/YR (METERED)
FY-81

FIGURE 1

TABLE 2

BASEWIDE

SUMMARY OF ENERGY USAGE (SITE)

FY-75

DESCRIPTION	ELECTRICITY (MBTU/YR)	NATURAL GAS (MBTU/YR)	F.O.#2 (MBTU/YR)	TOTAL (MBTU/yr)
PROCESS:	23,380	137,287	48,233	208,900
BLDG STM - CENTRAL PLANTS:	------	140,430	49,337	189,767
STEAM DISTRIBUTION SYSTEM:	------	80,424	28,256	108,680
BUILDING ENERGY:	4,886	6,682	------	11,568
ELECTRICAL MOTORS:	4,869	------	------	4,869
ELECTRICAL LOSSES:	3,298	------	------	3,298
FEEDER #7:	1,266	------	------	1,266
STREET LIGHTING:	933	------	------	933
UNACCOUNTED ENERGY:	5,084	2,995	------	8,079
TOTAL	43,716	367,818	125,826	537,360
METERED	43,716	367,818	125,826	537,360

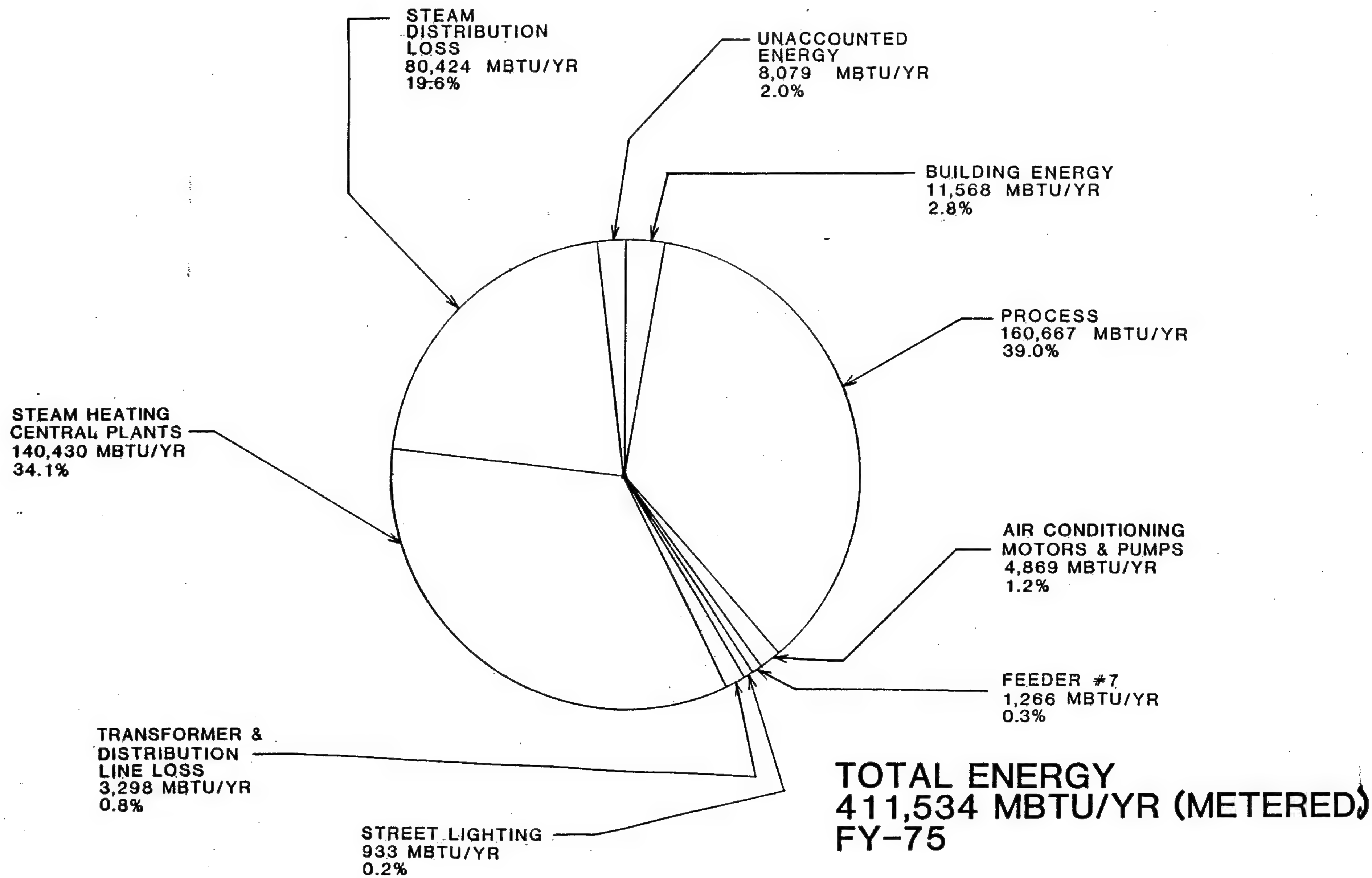

STEAM DISTRIBUTION LOSS 80,424 MBTU/YR 19.6%
UNACCOUNTED ENERGY 8,079 MBTU/YR 2.0%
BUILDING ENERGY 11,568 MBTU/YR 2.8%
PROCESS 160,667 MBTU/YR 39.0%
STEAM HEATING CENTRAL PLANTS 140,430 MBTU/YR 34.1%
AIR CONDITIONING MOTORS & PUMPS 4,869 MBTU/YR 1.2%
FEEDER #7 1,266 MBTU/YR 0.3%
TRANSFORMER & DISTRIBUTION LINE LOSS 3,298 MBTU/YR 0.8%
STREET LIGHTING 933 MBTU/YR 0.2%
TOTAL ENERGY 411,534 MBTU/YR (METERED)
FY-75

FIGURE 2

2.2 SOURCE ENERGY CONSUMPTION

2.2.1 The source energy consumption for FY'81 by energy types and costs is shown in Table 3.

2.2.2 The source energy consumption for FY'75 by energy types is shown in Table 4.

2.3 BUILDING GROUP SOURCE ENERGY CONSUMPTION

2.3.1 LHAAP facilities have been separated into eight functional building groups. Table 5 shows the total floor area and source energy consumption of each building group for FY'81.

2.3.2 Table 6 shows the total floor areas and source energy consumptions of the same building groups for FY'75.

TABLE 3

SOURCE ENERGY CONSUMPTION

FY'81

ENERGY	METERED QUANTITY	SOURCE MBTU	DOLLARS
ELECTRICITY	10,238,400 KWH	118,765	288,148
NATURAL GAS	4,205,270 THERMS	433,563	1,371,774

	Subtotal	552,328	
OTHER	NEGLIGIBLE	3,701	

TOTAL		556,029	

TABLE 4

SOURCE ENERGY CONSUMPTION

FY'75

ENERGY	METERED QUANTITY	SOURCE MBTU
ELECTRICITY	12,808,800 KWH	148,582
NATURAL GAS	3,678,180 THERMS	379,220
FUEL OIL	21,601 BARRELS	125,826
	Subtotal	653,628
OTHER	NEGLIGIBLE	18,908
TOTAL		672,536

TABLE 5

BUILDING GROUP SOURCE ENERGY CONSUMPTION
FY'81

ABBREV.	GROUP DESCRIPTION	FLOOR AREA	MBTU/yr
ADM	ADMINISTRATION	102,652	17,659
BLHR	BOILER HOUSE	26,203	18,068
GSTR	GENERAL STORAGE	17,370	2,267
GSUP	GENERAL SUPPORT	126,003	37,613
LABC	LABORATORY	18,125	6,960
PRD	PRODUCTION	326,276	145,097
PSTR	PRODUCTION STORAGE	218,757	17,329
PSUP	PRODUCTION SUPPORT	93,189	27,401

TABLE 6

BUILDING GROUP SOURCE ENERGY CONSUMPTION
FY'75

ABBREV.	GROUP DESCRIPTION	FLOOR AREA	MBTU/yr
ADM	ADMINISTRATION	102,652	14,698
BLHR	BOILER HOUSE	25,685	17,829
GSTR	GENERAL STORAGE	18,170	1,840
GSUP	GENERAL SUPPORT	124,634	34,600
LABC	LABORATORY	18,125	5,826
PRD	PRODUCTION	284,643	115,716
PSTR	PRODUCTION STORAGE	213,874	13,243
PSUP	PRODUCTION SUPPORT	90,646	24,470

3.0 ENERGY CONSERVATION MEASURES DEVELOPED

3.1 ECIP PROJECTS DEVELOPED

3.1.1 The ECIP Projects developed are listed in Tables 7, 8 and 9 with Source Energy Saved by each.

3.1.2 In addition to Projects listed, the ECM's investigated include the following:

A. Condensate Return for Plant #703-C

B. Replace Window A/C Units in Buildings 703 & 703-A with Water Source Heat Pumps

C. Energy Monitoring and Control System (EMCS)

3.1.3 These ECM's were not recommended for LHAAP because they are not economically feasible. The data transmission media for Energy Monitoring and Control is too expensive to install, and existing telephone lines for this purpose are presently over taxed. The Base has eliminated the feasibility for using radio signals for transmission because of possible frequency interference of signals with fuses in ammunition production.

TABLE 7

INCREMENT "A" PROJECTS

PROJECTS WITH SIR GREATER THAN 1

PROJ. NO.	PROJECT DESCRIPTION	ENERGY(*1) SAVED MBTU/YR	ENERGY SAVINGS ('83 $/yr)	PROJECT COST ('83 $)	SIR
1	ROOF INSULATION (RE VOL V)	10,889(G) 401(E)	49,565	295,391	2.2
2	WEATHERIZATION OF BUILDINGS (RE VOL V)	10,708(G) 410(E)	48,796	334,155	2.0
3	INSTALL THERMOSTATIC CONTROL VALVES ON STEAM MAINS	12,603(G)	55,705	30,153	25.0
4	LIGHTING PROJECT	1,064(E)	3,809(*2)	19,967	3.6
5	MOTOR REPLACEMENT	33.2(E)	119	495	2.9
6	LOADING DOCK DOOR SEALS	174(G)	769	5,920	1.8
7	AUTO IGNITION FOR GAS-FIRED WATER HEATERS	108(G)	477	4,106	1.6
8	WATER HEATER TIMER CONTROL (24 HOUR, AND 7 DAY).	248.4(E)	888	10,588	1.0
9	HIGH INTENSITY INFRARED HEATERS TO REPLACE UNIT HEATERS IN COMBINED SHOPS BLDG # 717	773(G) 17(E)	1,332	17,955	2.7
	TOTALS	35,255(G) 2,174(E)	161,460	718,730	

TABLE 8

INCREMENT "A" PROJECTS

PROJECTS WITH SIR LESS THAN 1

PROJ. NO.	PROJECT DESCRIPTION	ENERGY(*1) SAVED MBTU/YR	ENERGY SAVINGS ('83 $/yr)	PROJECT COST ('83 $)	SIR
10	AUTO IGNITION FOR GAS-FIRED UNIT HEATERS	178.8(G)	791	11,771	0.9
11	ECONOMIZER INSTALLATION	487.7(E)	1,492	45,310	0.5
12	ADDING FLOW RESTRICTORS TO SHOWER HEADS	24.3(G)	107	3,843	0.4
13	REPLACE EXTERIOR (STREET) LIGHTS	160(E)	573	22,131	0.3
14	ADDITION OF INSULATING JACKETS TO ELECTRIC WATER HEATERS	12.1(E)(*3)	N/A	1,719	0.3
15	SHUT-OFF ENERGY TO WATER HEATERS	10.7(G)	47	2,259	0.3
16	ADDITION OF THERMOSTATIC RADIATOR CONTROLS TO STEAM RADIATORS	582.7(G)	2,577	22,671	-7.4
	TOTALS	796(G) 652(E)	5,587	109,704	

TABLE 9

INCREMENT "B" PROJECTS

PROJECTS WITH SIR GREATER THAN 1

PROJ. NO.	PROJECT DESCRIPTION	ENERGY(*1) SAVED MBTU/YR	ENERGY SAVINGS ('83 $/yr)	PROJECT COST ('83 $)	SIR
17	DISCONNECT TRANSFORMERS NOT NEEDED	2,270(E)	9,738	3,280	26.2
18	STEAM TRAP REPLACEMENT	16,084(G)	71,090	45,864	11.5
	TOTALS	16,084(G) 2,270(E)	80,828	49,144	

*1 (G) Denotes Natural Gas, source
(E) Denotes Electricity, source

*2 Lamp savings not included: $2,475

*3 Due to synergistic effect, Electric energy saved is 4.0 MBTU/yr.

4.0 ENERGY SAVING AND COSTS

4.1 BASEWIDE CONSUMPTION AFTER ENERGY CONSERVATION PROJECTS

4.1.1 The reduction in annual energy consumption from FY'81 after implementation of all planned projects, or after implementation of only ECM's proposed by C-T-D, are shown in Table 10.

TABLE 10

CONSUMPTION SAVINGS FROM FY'81

PROJECT DESCRIPTION	ELEC MBTU	NAT. GAS MBTU	TOTAL E MBTU
FY'81 - ENERGY CONSUMPTION	118,765	433,563	552,328
ENERGY SAVINGS PROJECTS			
PLANNED BY LHAAP	(+) 642	(-) 57,054	(-) 56,412
ECM's BY C-T-D.	(-) 5,079	(-) 51,650	(-) 56,729
SUB-TOTAL	(-) 4,437	(-) 108,704	(-) 113,141
PROJECTED NET ENERGY USAGE (SOURCE)	114,328	324,859	439,187
CONSUMPTION SAVINGS FROM FY-81		20.5%	
ANNUAL ENERGY SAVINGS - ECM's By C-T-D FROM FY '81, MBTU/yr (source)		56,729	
CONSUMPTION SAVINGS FROM FY '81		10.8%	

4.1.2 The reduction in annual energy consumption from FY '75 by projects already completed and after implementation of all planned projects are shown in Table 11.

TABLE 11

CONSUMPTION SAVINGS FROM FY'75

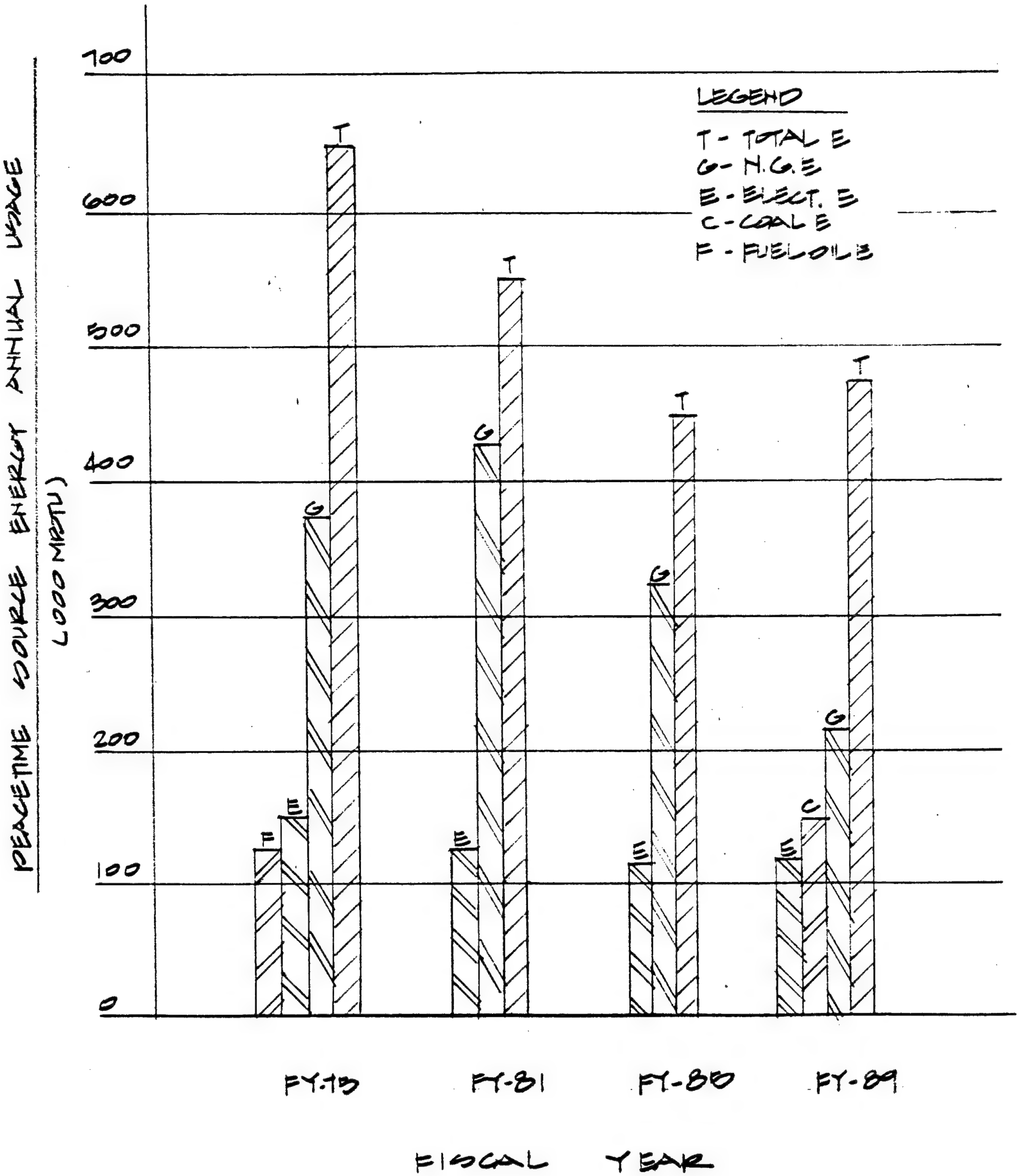
PROJECT DESCRIPTION	F. O. #2 MBTU	ELEC MBTU	NAT. GAS MBTU	TOTAL E MBTU
FY '75 ENERGY CONSUMPTION	125,826	148,582	379,220	653,628
ENERGY SAVING PROJECTS				
LHAAP COMPLETED		(-) 2,667	(-) 31,360	(-) 34,027
PLANNED BY LHAAP		(+) 642	(-) 57,054	(-) 56,412
ECM's BY C-T-D.		(-) 5,079	(-) 51,650	(-) 56,729
TOTAL		(-) 7,104	(-) 140,064	(-) 147,168
ANNUAL ENERGY SAVINGS FROM FY '75, MBTU/yr (source)				147,168
CONSUMPTION SAVINGS FROM FY '75				22.5%

4.2 **PROJECTED ENERGY CONSUMPTION**

4.2.1 The projected energy consumption shown in a bar graph, Figure 3, is peacetime source energy annual usage of fuels for FY '75, '81, '85 and '89.

4.2.2 The fuels of FY '89 include the conversion of Central Plant #401 from natural gas-fired boilers to coal-fired boilers. See Increment "E" (mod.), Central Boiler Plant Modernization, Vol III.

FIGURE 3
FUEL CONSUMPTION



4.3 PROJECTED ENERGY/COSTS

4.3.1 Table 12 shows projected energy and costs for fuels from FY '81 to FY '89. FY '89 is the scheduled year for coal-fired Central Boiler Plant Modernization to be implemented as outlined in Increment "E" (MOD.), Volume III. FY '83 costs are estimated based on escalated rates from survey year FY '81. Escalation factors projected from FY '83 are the same as found in LCCA analysis, Increment "E" (MOD.).

TABLE 12

SOURCE FUEL ENERGY/COSTS PROJECTION

FISCAL YEAR	ELEC. ENERGY (000) MBTU	ELEC. ENERGY (000) DOLLARS	NAT. GAS ENERGY (000) MBTU	NAT. GAS ENERGY (000) DOLLARS	COAL ENERGY (000) MBTU	COAL ENERGY (000) DOLLARS	TOTAL ENERGY (000) MBTU	TOTAL ENERGY (000) DOLLARS
1981	118.7	288.1*	433.6	1,371.8*	–		552.3	1,660.0
1983	118.7	425.0	433.6	1.916.5	–		552.3	2,341.5
RATE, $/MBTU		3.58		4.42				
1985	114.2	453.4	327.9	1,718.2	–		442.1	2,171.6
RATE, $/MBTU		3.97		5.24				
1989	114.2	458.0	205.0	1,074.2	146.5	378.0	465.7	1,910.1
RATE, $/MBTU		4.01		5.24		2.58		

* FROM LHAAP FUEL BILLINGS

5.0 INCREMENT "C" - RENEWABLE ENERGY

5.1 SOLAR

5.1.1 Preliminary evaluations for utilizing solar energy at LHAAP indicated that several buildings had potential for solar assist water heating systems. As for space heating/cooling systems analyzed, these were discarded early in the Study because they did not prove to be cost effective.

5.1.2 The following Buildings were considered for solar hot water systems:

A. Laundry #723
B. Cafeteria #708
C. Woman's Change House #102
D. Mens's and Women's Change House #103
E. Change House #707
F. Fire Station #709-A
G. Data Reduction and Change House #8-T
H. Administration #703 and #703-A
I. Steam/Power Plant #401 preheat system

5.1.3 These Buildings contain existing hot water systems which, for this study, are used as back-up for solar flat plate collector systems. Flat plate collectors are used as a basis in this report, with the exception of Plant #401, which also includes concentrating type collectors as an alternate consideration.

5.1.4 Thermal calculation methodology were obtained from "SOLCOST", a solar energy design computer program. Collector areas were optimized according to various army criterium.

5.1.5 Detailed economic evaluations reveal that solar projects are not viable investments at the Longhorn facilities. Therefore, they are not recommended.

5.2 BIOMASS

5.2.1 Biomass fuel is available from the forests of the LHAAP. About 15,000 tons per year can be cut on a renewable basis and an estimated 7,900 tons per year can be used for fuel under present harvesting management. The quantity of biomass available from Base harvesting is 35% of the peacetime yearly fuel requirements and is insufficient to sustain a biomass stoker boiler on a continuous basis. Additional biomass fuel can be purchased from surrounding forests at a cost comparable to that produced on the Base. It is not possible to ascertain the long-term availability of off-Base biomass fuel.

6.0 ENERGY PLAN

6.1 ENERGY/COST REDUCTIONS

6.1.1 The percent reductions by FY '85 are theoretical, since projects to be implemented are based upon and scheduled for FY '86 per Facilities Engineer. Energy reduction from FY '81 shows 10.8% with projects as developed by C-T-D in the EEAP study. An overall reduction from base FY '75 is estimated at 22.5% when all planned projects by the study and by the Base are completed. Re, Table 12.

6.1.2 The Estimated Costs for fuels from FY '83 to FY '85 will be reduced by 7.3%.

6.1.3 By 1989, when coal-fired boilers are on the line as depicted in Boiler Plant Modernization, the estimated fuel costs will drop 18% from that of FY '83.

6.2 ENERGY USAGE BY FLOOR AREA

6.2.1 Energy usage per square foot by 1985 is 0.314 MBTU/sf.

EXECUTIVE SUMMARY

MODERNIZATION PROGRAM
FOR
CENTRAL BOILER PLANT

(INCREMENT E MOD.)

LONGHORN ARMY AMMUNITION PLANT

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MODERNIZATION PROGRAM FOR CENTRAL BOILER PLANT

1.0 INTRODUCTION

1.1 BACKGROUND

1.1.1 The Longhorn Army Ammunition Plant (LHAAP) is located northeast of Marshall, Texas in Harrison County. LHAAP was constructed to manufacture TNT in 1942. Present production is a variety of pyrotechnic and illuminating devices. The present Operating Contractor is Thiokol Corporation.

1.1.2 The Central Boiler Plant of this modernization study is located in Building No. 401. This Boiler Plant generates heating and process steam for much of the Base. The steam is distributed tibuted through two above ground piping lines. Originally, the Central Boiler Plant had four boilers, with a capacity of 100,000 pounds per hour each, producing saturated steam at a pressure of 150 psig. All units burn natural gas or fuel oil.

1.1.3 Currently, three boilers are operational and only one boiler is needed to supply the present yearly steam requirements. The fourth boiler has been disabled.

1.1.4 A recent inspection and evaluation of Boiler No. 1. and boiler house auxiliary systems reported them to be in generally good condition. Their useful life can be extended if recommended repairs and other improvements detailed in the report are provided. A performance test of Boiler No. 2 gave a calculated thermal efficiency of approximately 82%.

1.2 OBJECTIVES

1.2.1 The Central Boiler Plant modernization objective is to establish the most cost-effective and technically practical scheme for modernizing the Boiler Plant and develop a modernization program plan. The scheme is to meet the heating and process steam requirements based on historical usage rates. FY 1981 was the basis of Peacetime consumption and FY 1970 was Mobilization consumption.

1.2.2 Table 1 shows the heating and process steam required by Longhorn AAP to support the production facilities.

TABLE 1

STEAM PRODUCTION REQUIREMENTS

LOAD, POUNDS PER HOUR	PEACETIME	MOBILIZATION
Summer Average	24,100	44,700
Winter Average	48,700	82,800
Winter Peak	69,240	92,700
Annual Average	35,000	63,400

1.2.3 Other objectives are to conform to energy conservation and utilization policies of the Government and Army regulations and environmental protection as governed by Environmental Protection Agency and the State of Texas. Coal is to be considered as a primary boiler fuel and the feasibility of biomass as a primary fuel in lieu of coal is to be investigated. The feasibility of steam/power co-generation is to be established.

1.2.4 The final report of the study is to include a proposed program plan containing two options: (1) Option A which is the most cost effective scheme on a 25 year life-cycle basis and (2) Option B which requires the least amount of capital outlay.

1.3 SELECTION CRITERIA

1.3.1 The technical criteria for selection of a modernization program that meets the study objective were coal supply, site arrangement, ash disposal, existing Boiler Plant capacity and physical condition, shutdown period required for modernization, ongoing or planned Boiler Plant projects and information developed by other Increments of this Contract.

1.3.2 The economic criteria for selection of a modernization program were capital cost, operating and maintenance costs, labor costs and fuel costs and escalation. For the life-cycle cost analysis, a net present value calculation establishes the most cost effective scheme.

1.3.3 Life cycle cost analysis was performed according to guidelines defined by ETL-3-332 Part I, 22 March, 1982. The life cycle period was twenty-five years which includes two mobilization periods totaling twelve years. The remaining thirteen years were peacetime years.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 EXISTING FACILITIES

2.1.1 The existing Central Boiler Plant (Building No. 401) and its three older boilers apparently are in good operating condition and can continue to supply steam for several more years. A new 60,000 pound per hour gas-fired boiler is under LHAAP planning based upon boiler replacement. For this Study, this new boiler was considered as existing. Their operation is contingent upon the available supply of gas and oil fuel to LHAAP and future government policies regarding the use of petroleum based fuels. The total capacity of the existing boilers is excessive for the present Longhorn AAP mobilization steam demand.

2.1.2 The existing boiler house and boilers were designed and constructed for burning natural gas and fuel oil. It is impracticable to convert this facility to burn a solid fuel such as coal or biomass because of incongruity of the boiler house configuration and the internal arrangement of the individual boilers. Therefore, a new Power House is required for solid fuel-fired units.

2.1.3 The existing Boiler Plant need not be abandoned or demolished. Several existing auxiliary systems can serve the new proposed Power House and some steam driven equipment can continue their function by receiving their steam supply from the new Power House. The existing boilers can be retained in a back-up role to the new Power House at a substantial capital cost savings.

2.2 ENERGY SOURCE

2.2.1 Bituminous coal with a minimum heating value of 10,000 BTU/lb and a sulfur range of 2% - 4% has been selected for this study. Various coal suppliers can furnish this grade coal to Longhorn AAP on a

continual basis. The stoker fired boilers and air pollution control equipment for the modernization plan are selected for this coal. Stoker firing requires the use of sized coal.

2.2.2 Biomass fuel is available from the forests of the LHAAP. About 15,000 tons per year can be cut on a renewable basis and an estimated 7,900 tons per year can be used for fuel under present harvesting management. The quantity of biomass available from Base harvesting is 35% of the peacetime yearly fuel requirements and is insufficient to sustain a biomass stoker boiler on a continuous basis. Additional biomass fuel can be purchased from surrounding forests at a cost comparable to that produced on the Base. It is not possible to ascertain the long-term availability of off-Base biomass fuel.

2.3 PROPOSED POWER HOUSE

2.3.1 A new coal-fired central boiler house facility operating at saturated steam conditions of 165 psig pressure is the recommended and proposed scheme. This scheme has the lowest Net Present Value calculated from the 25 year Life Cycle Cost Analysis. The capital cost for the recommended scheme is 1.07% more than the scheme requiring the least amount of capital outlay. Thus, the proposed scheme fulfills the requirements of Option A of the selection procedure given in the Scope of Work and nominally fulfills the requirements of Option B.

2.3.2 Two other schemes evaluated for the new Power House included a scheme that is the same as the recommended scheme except one boiler is dedicated to burn biomass fuel and has a biomass handling and storage system. The other scheme has two larger boilers, one operating at 500 psig, 575°F steam conditions with a topping turbine/generator for co-generation of electricity. The turbine exhaust conditions are 165 psig. These schemes were less cost effective, less standard in design and equipment and more complex to operate than the recommended scheme.

2.3.3 The proposed Power House consists of three 35,000 pounds per hour coal-fired feeder-stoker boilers with economizers, fly-ash reinjection, new coal handling and storage system, pollution control equipment and other support and ancilliary systems. The capacity of the proposed Power House will meet, with adequate reserve, the Longhorn AAP mobilization process and heating steam demands.

2.3.3.1 Three boilers are recommended to limit boiler turndown and improve boiler efficiency. Any one boiler will supply the Peacetime Summer steam load and any two boilers can satisfy all other Peacetime steam loads, including winter peak loads. During Mobilization, any two boilers will supply the Summer steam and all three boilers will be required to meet the steam loads for the remainder of the year.

2.3.3.2 Two new deaerators and storage tanks, three feedwater pumps and blowdown systems are provided to insure adequate boiler water capacity and flexibility. Softened boiler make-up water will be piped from the existing sodium-zeolite softening system, then boiler chemical treated by a new injection system. To utilize the existing LHAAP steam distribution system to the various process buildings, a new steam and make-up water pipe bridge will connect the existing Boiler Plant to the proposed Power House.

2.3.3.3 The coal handling system is designed for train or truck deliveries and the coal can be conveyed directly to the Power House or to the coal storage pile at a rate of 150 tons per hour. Coal is reclaimed from the storage pile through a below grade hopper and conveyed to the Power House and directed to the boiler bunkers by a powered Tripper. The coal is handled on troughing belt conveyors having feeders to control the flow rate from hoppers. Delivered coal is weighed by a belt scale and reclaimed coal is weighed by a weighbelt feeder. The coal handling system is designed for automatic operation and includes two magnetic separators, a crusher with by-pass, dust suppression, sump pumps and fire protection. The coal storage pile is sized for a 90-day supply and the boiler bunkers provide 48 hours of full load coal during winter mobilization periods. The

coal pile runoff is drained into an evaporation pond. Water is pumped from the pond for use by the Dust Suppression System, Coal Handling Washdown System and the ash silo dustless unloader.

2.3.3.4 The flue gas pollution control system consists of a spray absorption dry scrubber, using pebble lime as a reagent, for sulfur dioxide emissions control. This is followed by an air pulse baghouse for particulate emissions control. The dry scrubber is a newer technology offering significant cost savings and simplified operations over conventional wet scrubbers. The proposed equipment will satisfy stack air quality environmental regulations. All ash will be collected by a pneumatic system to a storage silo than transported by ash trucks to an on site dedicated non-hazardous ash landfill.

2.3.4 The electrical power supply for the new Power House originates from the existing Boiler Plant. The feeder will be from an existing spare circuit of the distribution bus. The main incoming feeder and the Power House's distribution system is connected to a 7,600 volt switchgear line-up located on the first floor. All of the motor control centers and power panels in the Power House will be 480 VAC. Two diesel engine driven 100 KW generators will supply emergency power for Power House operation when Utility supply is lost.

2.4 PROPOSED POWER HOUSE ECONOMICS

2.4.1 The estimated total capital cost for the proposed new Central Power House is $21,497,000 in 1983 dollars. It includes an overall contingency of 10%. Table 2 shows the itemized cost estimate for the proposed facility.

2.4.2 The operating costs summary for peacetime and mobilization periods is shown on Table 3. The summary includes costs for fuel, power chemicals, labor, maintenance, and ash disposal. For the new Power House, the yearly operating costs in 1983 dollars are $3,264,050 for peacetime and $5,268,330 for mobilization, which are higher than the present operating costs. Higher operating costs for the proposed Power House are expected due to the increased complexity of a solid-fueled facility versus a petroleum-fueled facility. The equipment for fuel handling, ash handling and pollution abatement add to labor and maintenance costs.

2.4.3 The new Power House will reduce the yearly natural gas consumption of LHAAP 363,100 Kcf during peacetime and 647,275 Kcf during mobilization periods.

3.0 PROGRAM PLAN

3.1 PROGRAM DESCRIPTION

3.1.1 The modernization program plan presented is based on two premises:

a) The existing boilers and auxiliary systems can continue to supply the steam requirements of LHAAP into the year 1990. The existing Boiler Plant can provide steam in a back-up operational role to the new Power House for possibly 25 years.

b) An adequate natural gas and fuel oil supply will continue to be available and government policies will allow use of petroleum based fuels as programmed through the life of the plan.

3.1.2 A single-phase program is planned for development of the new facility. The small size of the facility and the elimination of back-up solid-fueled boiler capacity limits flexibility in the proposed program plan to accommodate imposed fiscal constraints. All of the proposed facilities Systems and features are vital to the satisfactory operation of the new facility, so to defer any Systems will penalize the cost effectiveness of the plan. In an inflationary economic period, a shortened project time reduces the overall cost of the project.

3.1.3 If four years are allowed for construction of the new facility and the goal is having the new facility on line by 1990, the proposed Power House project should be initiated during 1986. The program schedule and the associated funding profile have been developed for this time period. The construction schedule can be initiated at any earlier or later time to suit the actual requirements of LHAAP.

3.1.4 The single-phase of the modernization program is to construct the new facility as one project, consisting of three coal-fired boilers of 35,000 pounds per hour steam capacity each in a new building with auxiliary equipment, a new coal handling and storage system, new air pollution abatement equipment and other systems. The estimated capital cost for the project is $21,497,000 in 1983 dollars. The Program Schedule is shown in Figure 1.

3.1.5 A funding profile was developed from the program schedule and the capital cost estimate. Table 4 and Figure 2 show the yearly funds required during implementation of the modernization program in 1983 dollars. The largest annual funding of $13,600,000 occurs in FY 1988.

3.2 ITEMS AFFECTING THE PROGRAM PLAN

3.2.1 The following items may affect the overall modernization program plan:

a) The estimated cost for ash disposal and the landfill site is adequate to satisfy the current solid waste disposal regulations. Should these regulations become more stringent, the ash disposal cost to the landfill area would increase.

b) A change in the mission of LHAAP requiring a major base expansion or reactivation of laid away facilities that would have an affect on the required steam capacity of the proposed Power House.

3.3 AREAS OF FURTHER ACTION

3.3.1 The following are technical items which must proceed implementation of the recommendations:

a) The regional natural gas supply situation should be closely monitored for early recognition of potential problems concerning a steady supply of natural gas to Longhorn AAP.

b) The systems and associated costs presented for ash disposal, flue gas scrubbing and particulate control, coal pile runoff and make-up water treatment are adequate for general compliance with current regulations. Until the permit applications are officially processed by the Agencies, some detail design features of the proposed Power House cannot be finalized.

c) Meters to monitor and record steam production, heating and process steam distribution and usage, make-up water usage and electrical usage as'a function of time should be installed in the existing Central Boiler Plant. This information is desireable to the assessement of steam usage and possible energy savings in the final design of the Proposed Power House.

TABLE 2

LONGHORN ARMY AMMUNITION PLANT
MODERNIZATION PROGRAM
SUMMARY CAPITAL COST ESTIMATE
($000)

	PROPOSED POWER HOUSE
Direct Cost	
1.0 Site Work	747.7
2.0 Buildings	2,005.4
3.0 Steam/Power Systems	3,326.7
4.0 Combustion Systems	9,617.6
5.0 Electric & Control Systems	1,644.0
Direct Costs	17,341.4
6.0 Indirect Costs	2,201.0
Subtotal	19,542.4
7.0 Contingency	1,954.6
TOTAL CAPITAL COSTS (1983)	21,497.0

For cost details, See Volume III, Table 9-2.

TABLE 3

LONGHORN ARMY AMMUNITION PLANT

BOILER PLANT MODERNIZATION STUDY

SUMMARY YEARLY OPERATING COSTS

DESCRIPTION	PEACETIME EXISTING	PEACETIME PROPOSED POWER HOUSE	MOBILIZATION EXISTING	MOBILIZATION PROPOSED POWER HOUSE
BOILER CONDITIONS IN PSIG/°F	165/SAT	165/SAT	165/SAT	165/SAT
Heat Input In MBTU/HR.	41.450	51.775	73.890	93.265
Power Generated In KW	-	-	-	-
Power Required For Plant In KW	1,220	1,375	2,435	2,805
Fuel Costs	1,665,745	1,290,380	2,951,580	2,322,000
Electrical Costs	444,580	501,100	923,770	1,022,100
Water Costs	50,510	59,130	88,145	99,545
Chemical Costs	4,275	128,400	7,695	231,075
Operating Labor Costs	218,400	917,280	349,440	1,092,000
Maintenance (Parts & Labor) Costs	164,700	363,400	285,800	493,760
Disposal Transportation Costs	-	4,360	-	7,850
Yearly Operating Costs (1983)	$2,538,210	$3,264,050	$4,606,430	$5,268,330

For cost details, See Volume III.

FIGURE 1

LONGHORN ARMY AMMUNITION PLANT

MODERNIZATION PROGRAM SCHEDULE

SCHEME A OR B

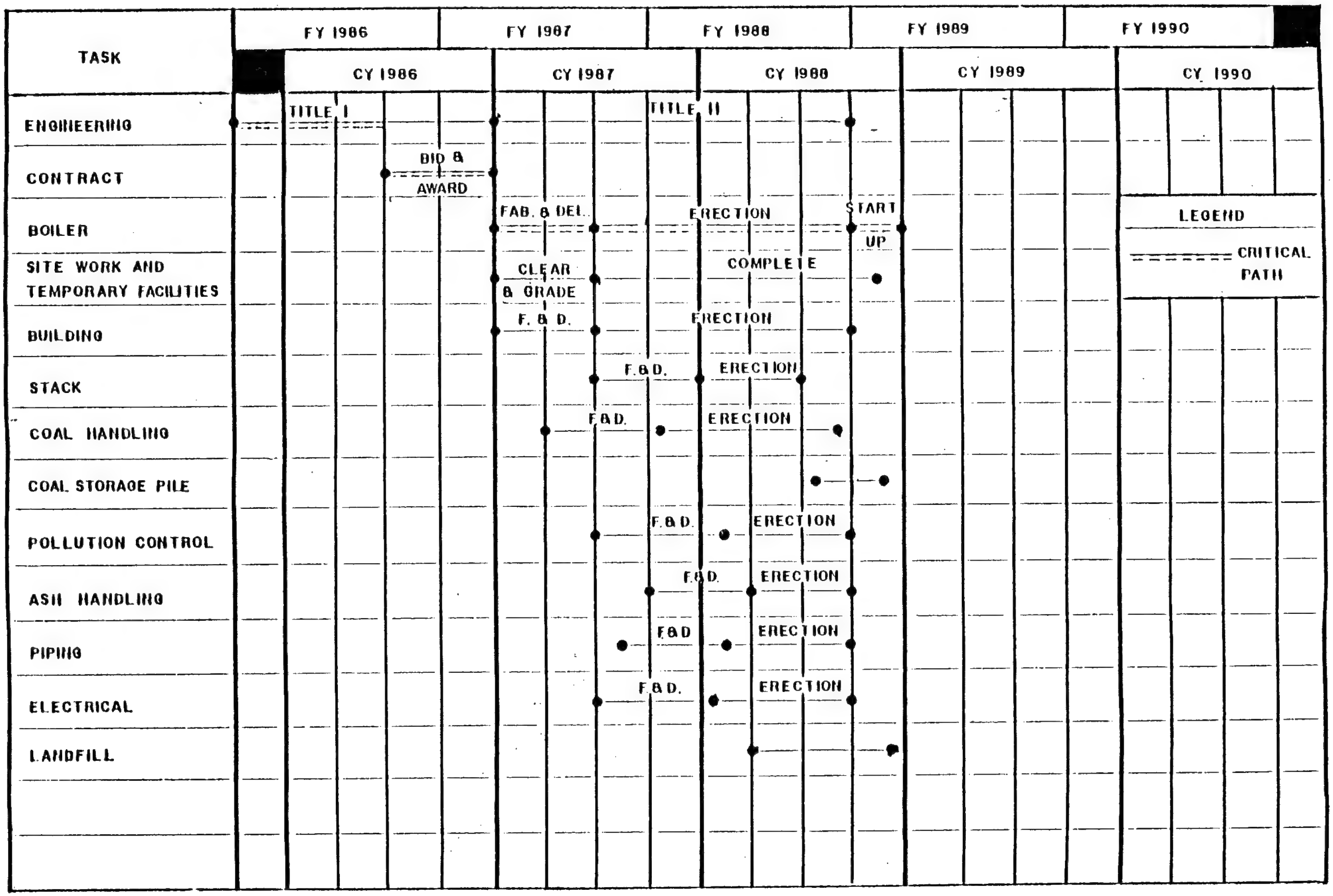


TABLE 4

LONGHORN ARMY AMMUNITION PLANT

MODERNIZATION PROGRAM

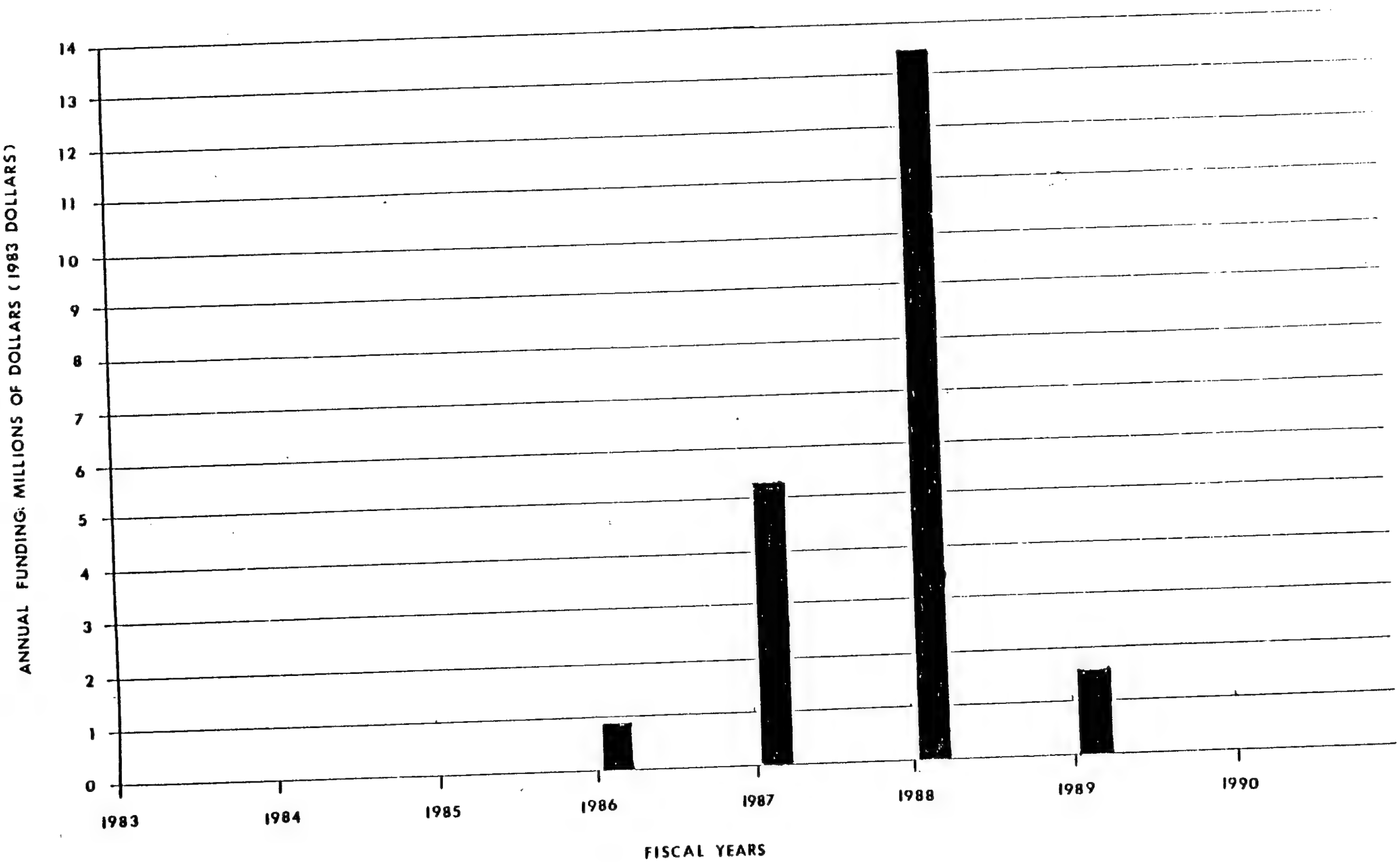
FUNDING PROFILE

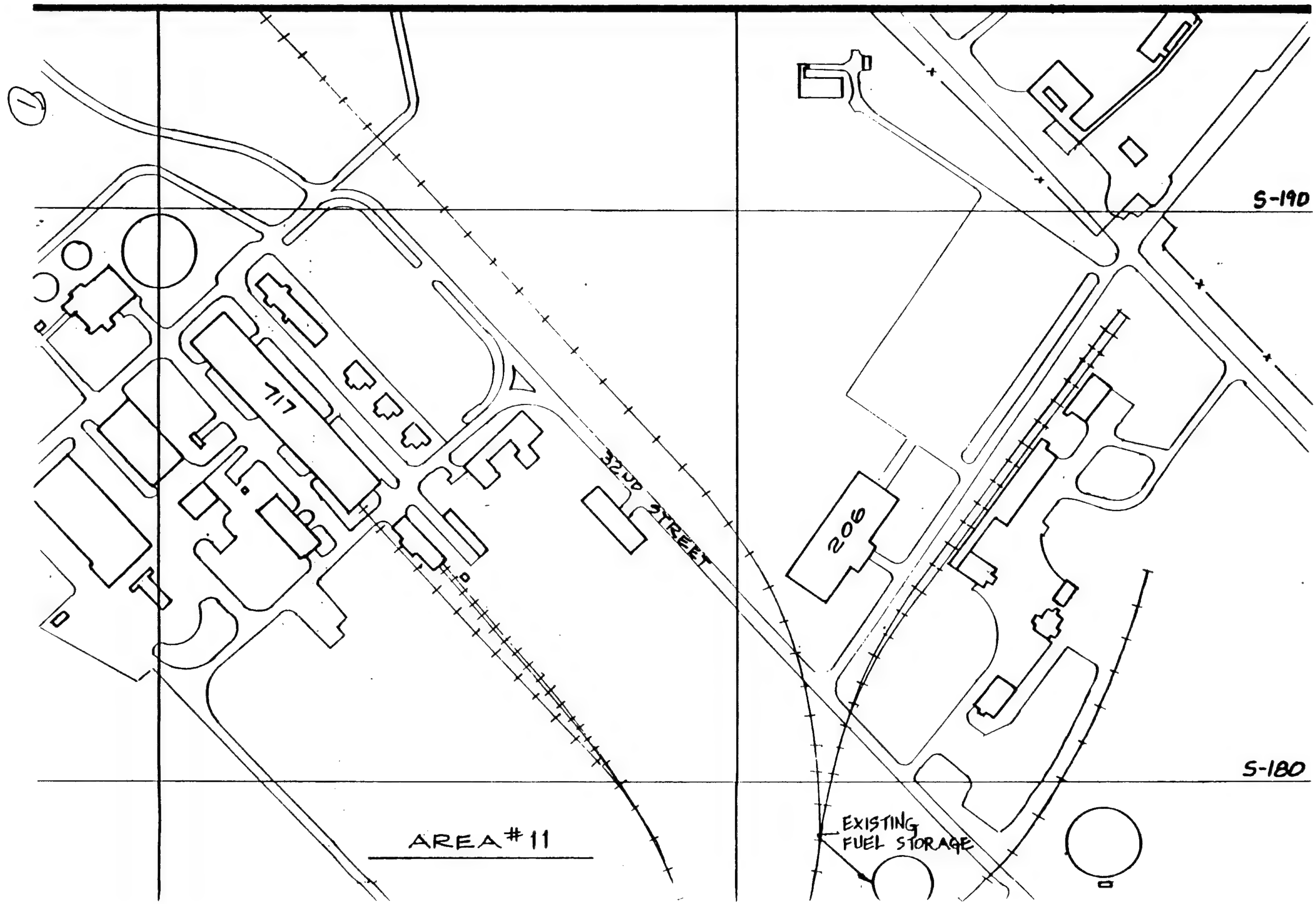
($000)

FISCAL YEAR	1983 DOLLARS
1983	-
1984	-
1985	-
1986	$ 918
1987	5,339
1988	13,600
1989	1,640
TOTAL	$21,497

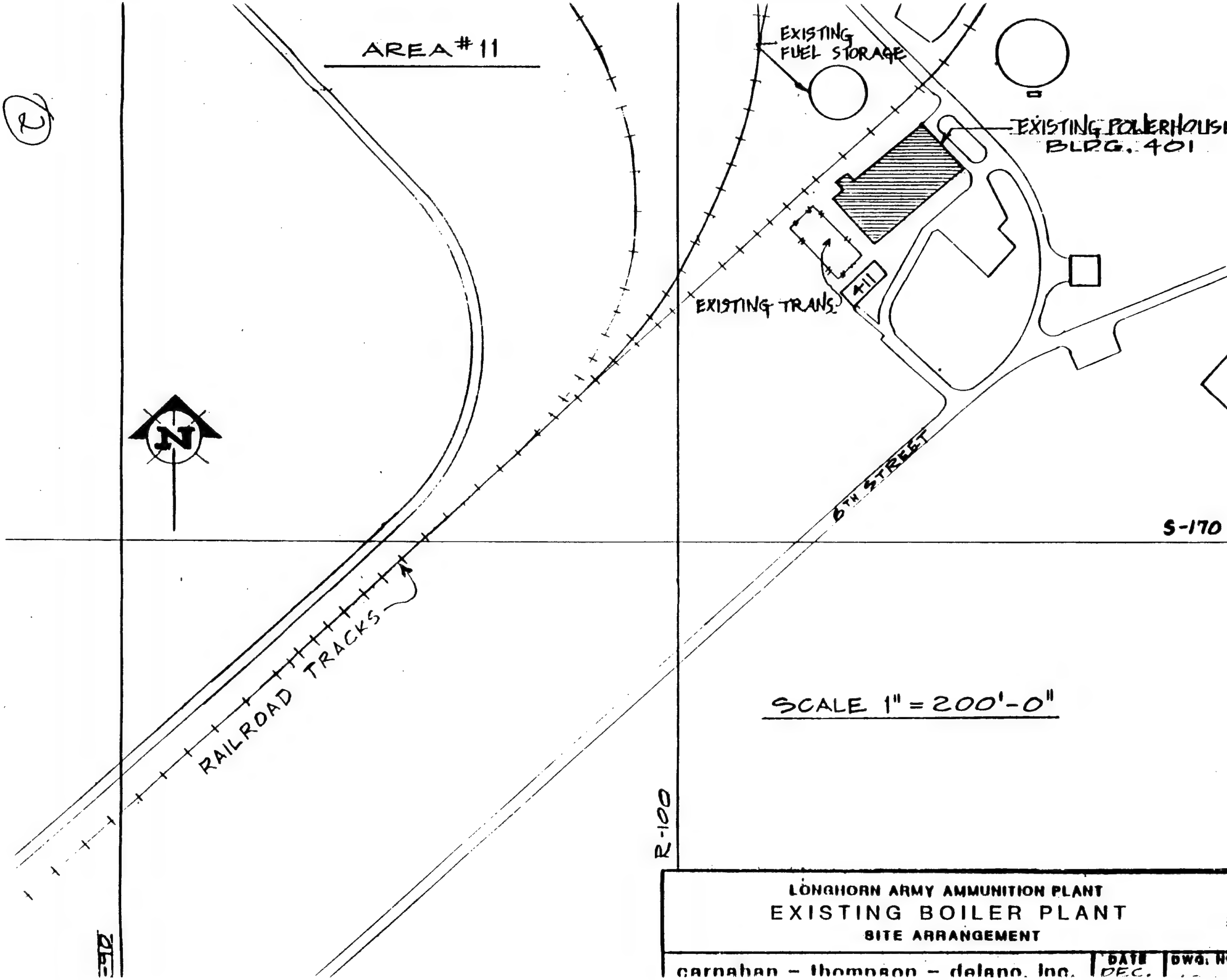
FIGURE 2

LONGHORN ARMY AMMUNITION PLANT
FUNDING PROFILE

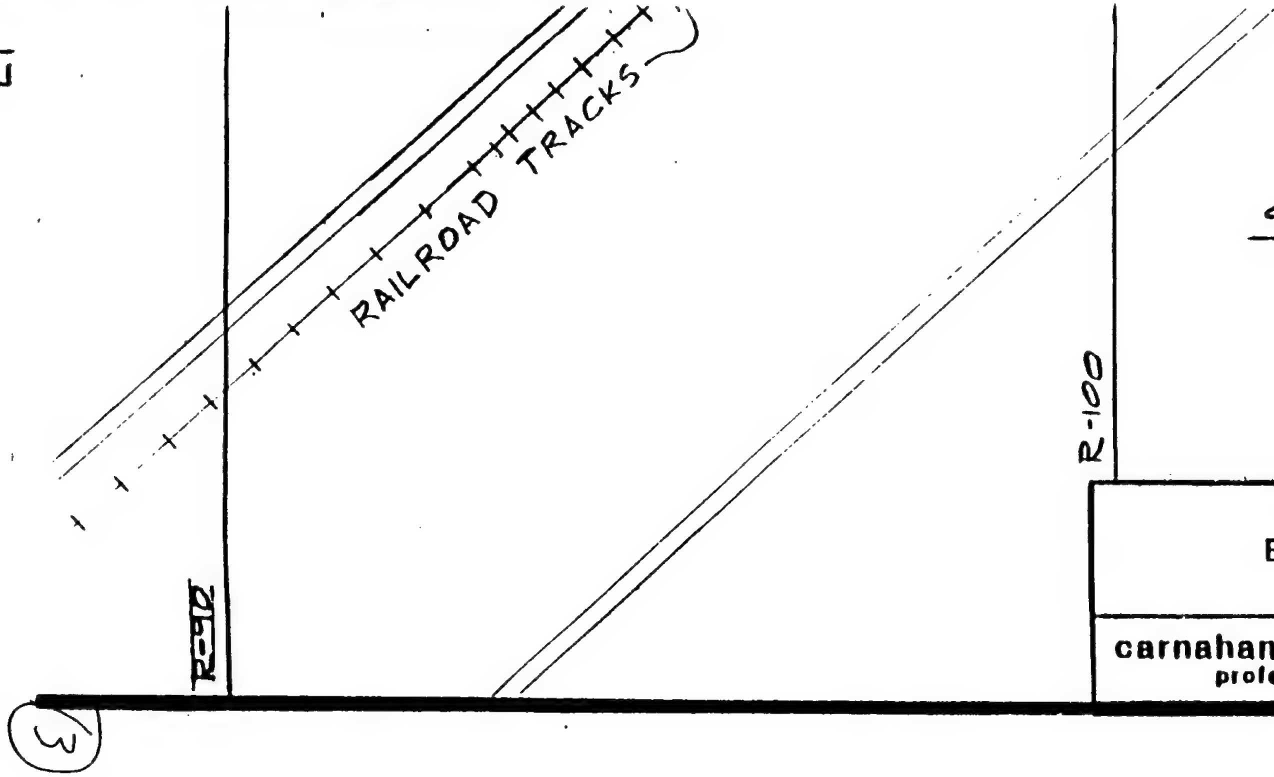




1
S-190
S-180
717
206
32ND STREET
EXISTING
FUEL STORAGE
AREA #11



AREA # 11
EXISTING FUEL STORAGE
EXISTING POWERHOUSE BLDG. 401
EXISTING TRANS.
4-11
6TH STREET
RAILROAD TRACKS
S-170
R-100
SCALE 1" = 200'-0"
LONGHORN ARMY AMMUNITION PLANT
EXISTING BOILER PLANT
SITE ARRANGEMENT
carnahan - thompson - delano, Inc.
DATE
DEC.
DWG. NO.
N
2



SCALE 1" = 200'-0"

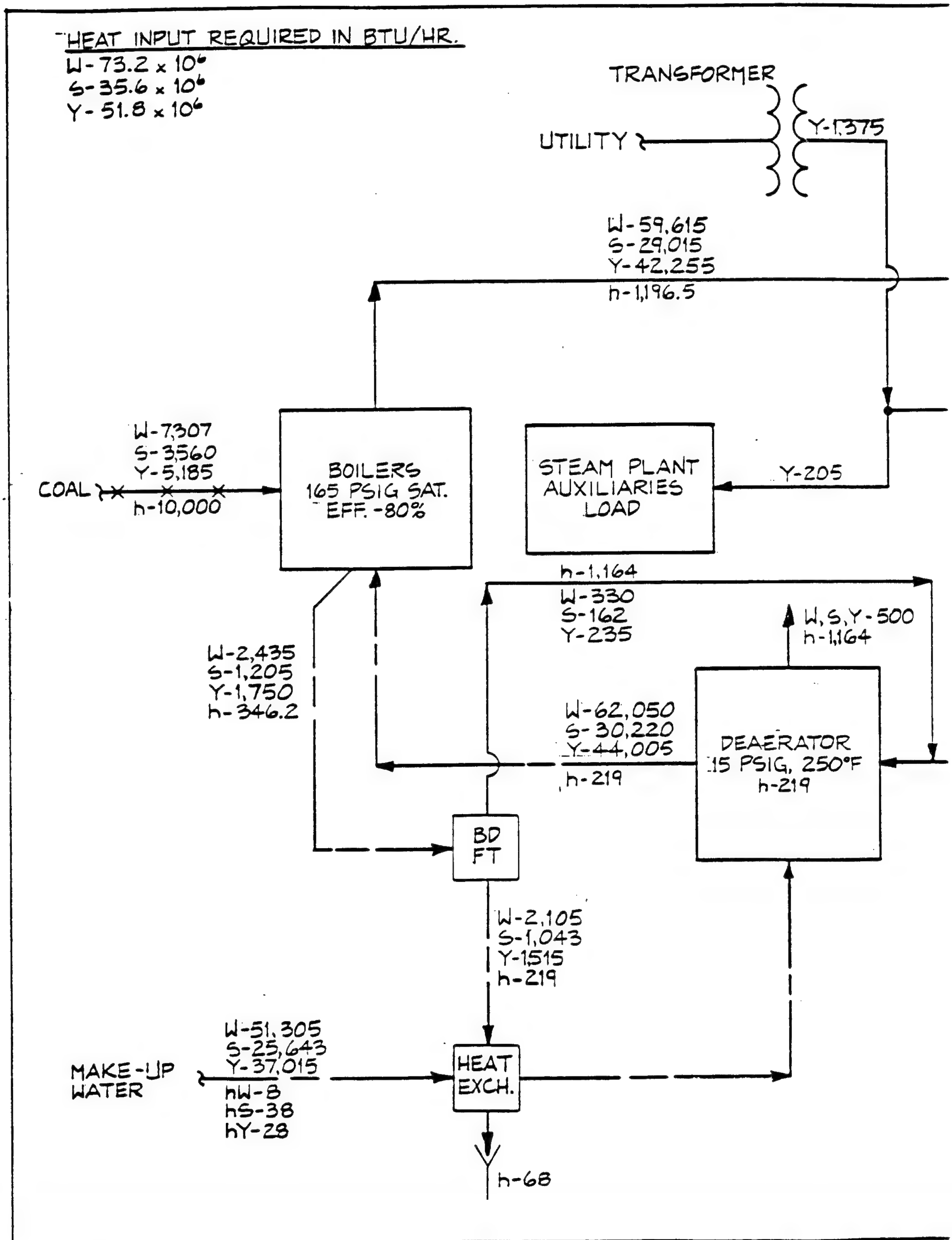
LONGHORN ARMY AMMUNITION PLANT

EXISTING BOILER PLANT

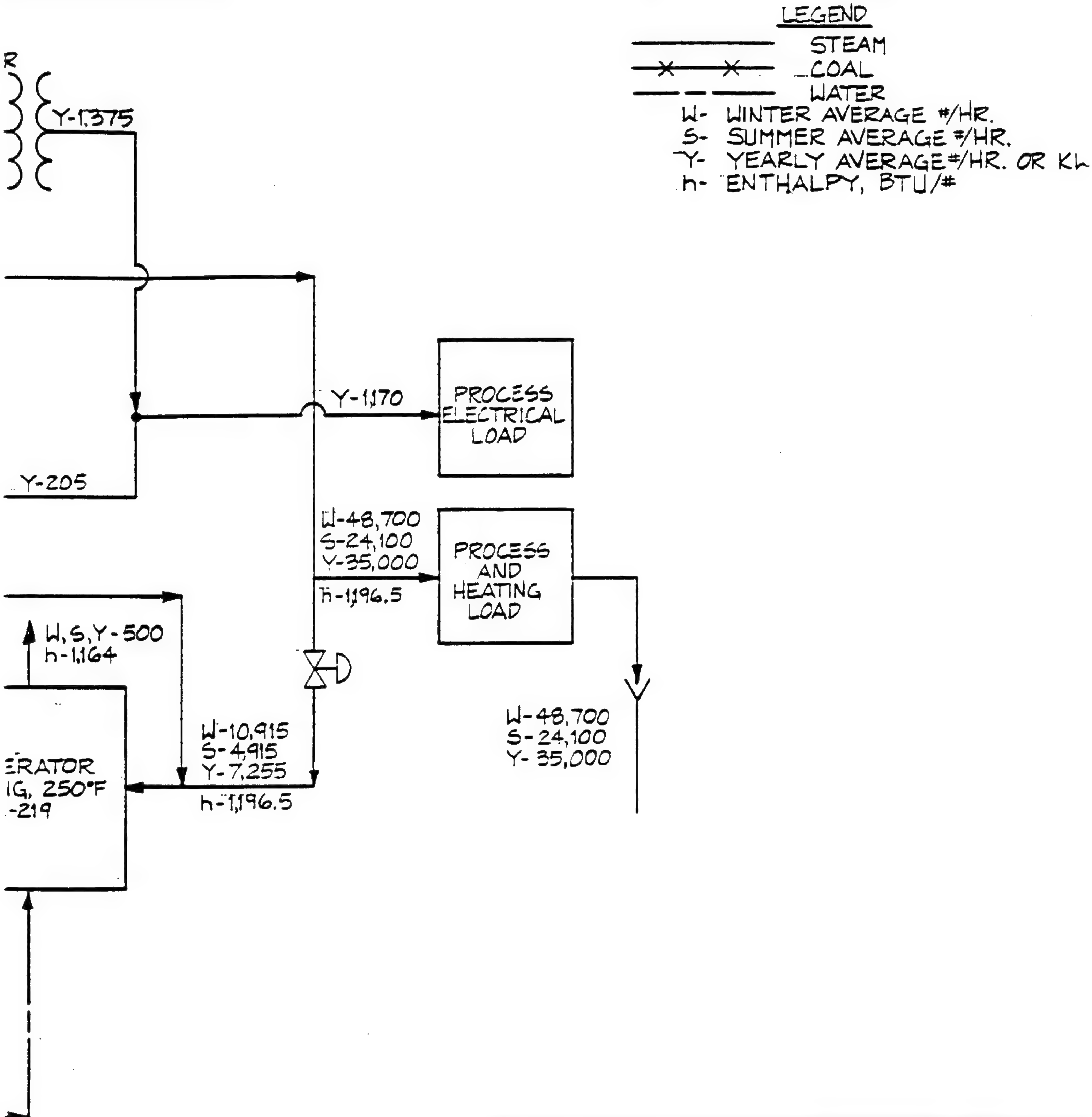
SITE ARRANGEMENT

carnahan - thompson - delano, Inc. professional consulting engineers	DATE DEC. 1983	DWG. NO. 100

3


HEAT INPUT REQUIRED IN BTU/HR.
W-73.2 x 10^6
S-35.6 x 10^6
Y-51.8 x 10^6
TRANSFORMER
UTILITY
Y-1,375
W-59,615
S-29,015
Y-42,255
h-1,196.5
W-7,307
S-3,560
Y-5,185
COAL
h-10,000
BOILERS
165 PSIG SAT.
EFF. -80%
STEAM PLANT
AUXILIARIES
LOAD
Y-205
h-1,164
W-330
S-162
Y-235
W,S,Y-500
h-1,164
W-2,435
S-1,205
Y-1,750
h-346.2
W-62,050
S-30,220
Y-44,005
h-219
DEAERATOR
15 PSIG, 250°F
h-219
BD
FT
W-2,105
S-1,043
Y-1,515
h-219
MAKE-UP
WATER
W-51,305
S-25,643
Y-37,015
hW-8
hS-38
hY-28
HEAT
EXCH.
h-68

1



LONGHORN ARMY AMMUNITION PLANT

SCHEME B

HEAT BALANCE DIAGRAM FOR 165 PSIG SAT. PEACETIME

carnahan – thompson – delano, inc.
professional consulting engineers

DATE DEC, 1983

2

LEGEND

STEAM

COAL

WATER

WINTER AVERAGE #/HR.

SUMMER AVERAGE #/HR.

YEARLY AVERAGE #/HR. OR KW

ENTHALPY, BTU/#

ORN ARMY AMMUNITION PLANT

SCHEME B

DIAGRAM FOR 165 PSIG SAT. PEACETIME

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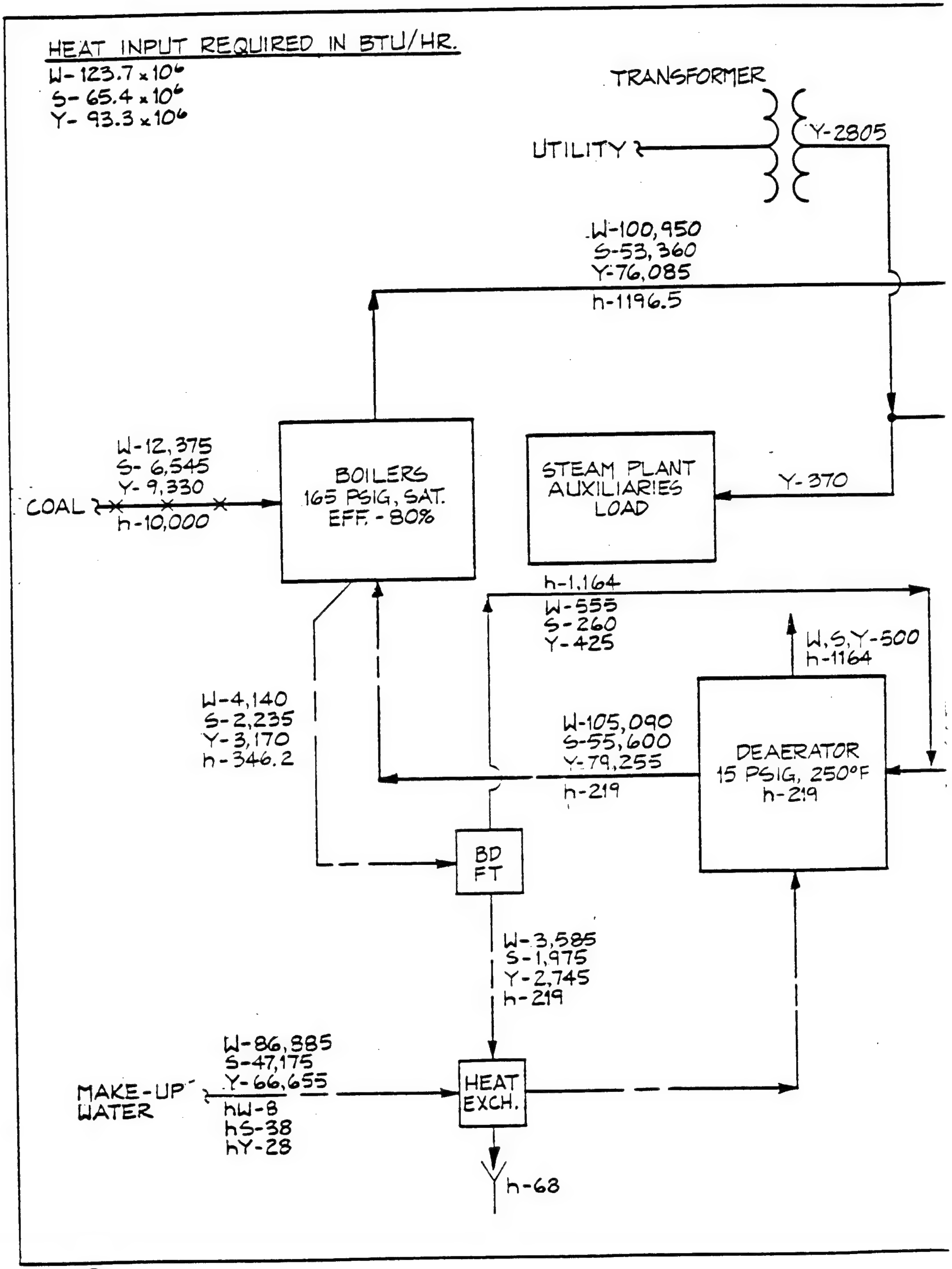
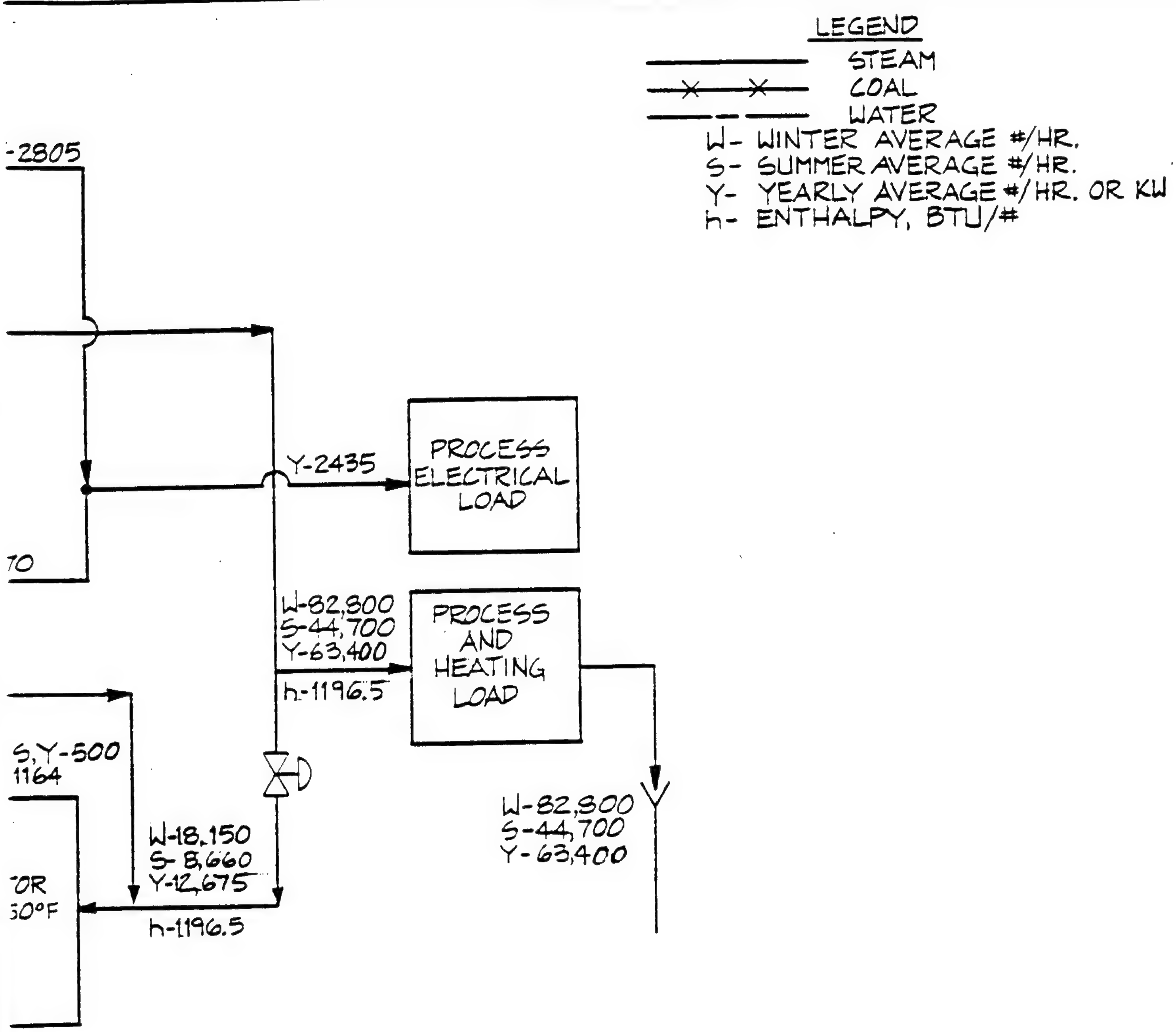

HEAT INPUT REQUIRED IN BTU/HR.
W- 123.7 x 10^6
S- 65.4 x 10^6
Y- 93.3 x 10^6
TRANSFORMER
UTILITY
Y-2805
W-100,950
S-53,360
Y-76,085
h-1196.5
W-12,375
S- 6,545
Y- 9,330
COAL
h-10,000
BOILERS
165 PSIG, SAT.
EFF. - 80%
STEAM PLANT
AUXILIARIES
LOAD
Y- 370
h-1,164
W-555
S-260
Y-425
W,S,Y-500
h-1164
W-4,140
S-2,235
Y-3,170
h-346.2
W-105,090
S-55,600
Y-79,255
h-219
DEAERATOR
15 PSIG, 250°F
h-219
BD
FT
W-3,585
S-1,975
Y-2,745
h-219
W-86,885
S-47,175
Y-66,655
MAKE-UP
WATER
hW-8
hS-38
hY-28
HEAT
EXCH.
h-68

1



LONGHORN ARMY AMMUNITION PLANT

SCHEME B

HEAT BALANCE DIAGRAM FOR 165 PSIG SAT. MOBILIZATION

carnahan – thompson – delano, inc. professional consulting engineers	DATE DEC. 1983	DWG. 111

(2)

LEGEND

STEAM

COAL

WATER

JINTER AVERAGE #/HR.

SUMMER AVERAGE #/HR.

YEARLY AVERAGE #/HR. OR KW

ENTHALPY, BTU/#

HORN ARMY AMMUNITION PLANT

SCHEME B

IAGRAM FOR 165 PSIG SAT. MOBILIZATION

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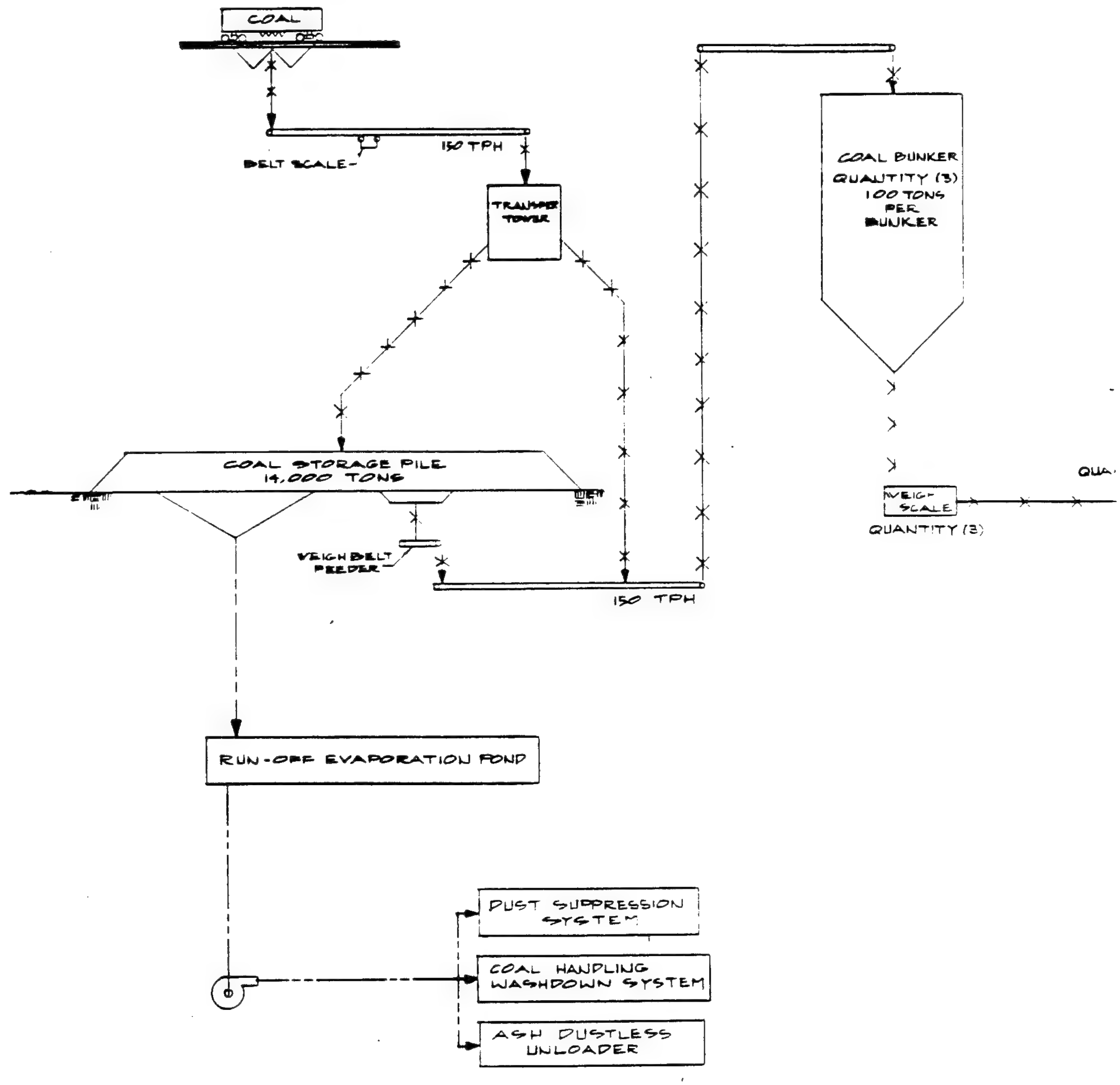
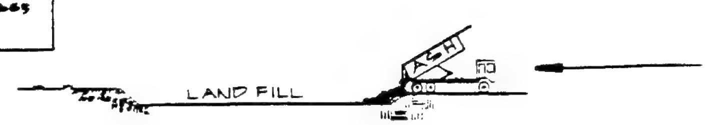
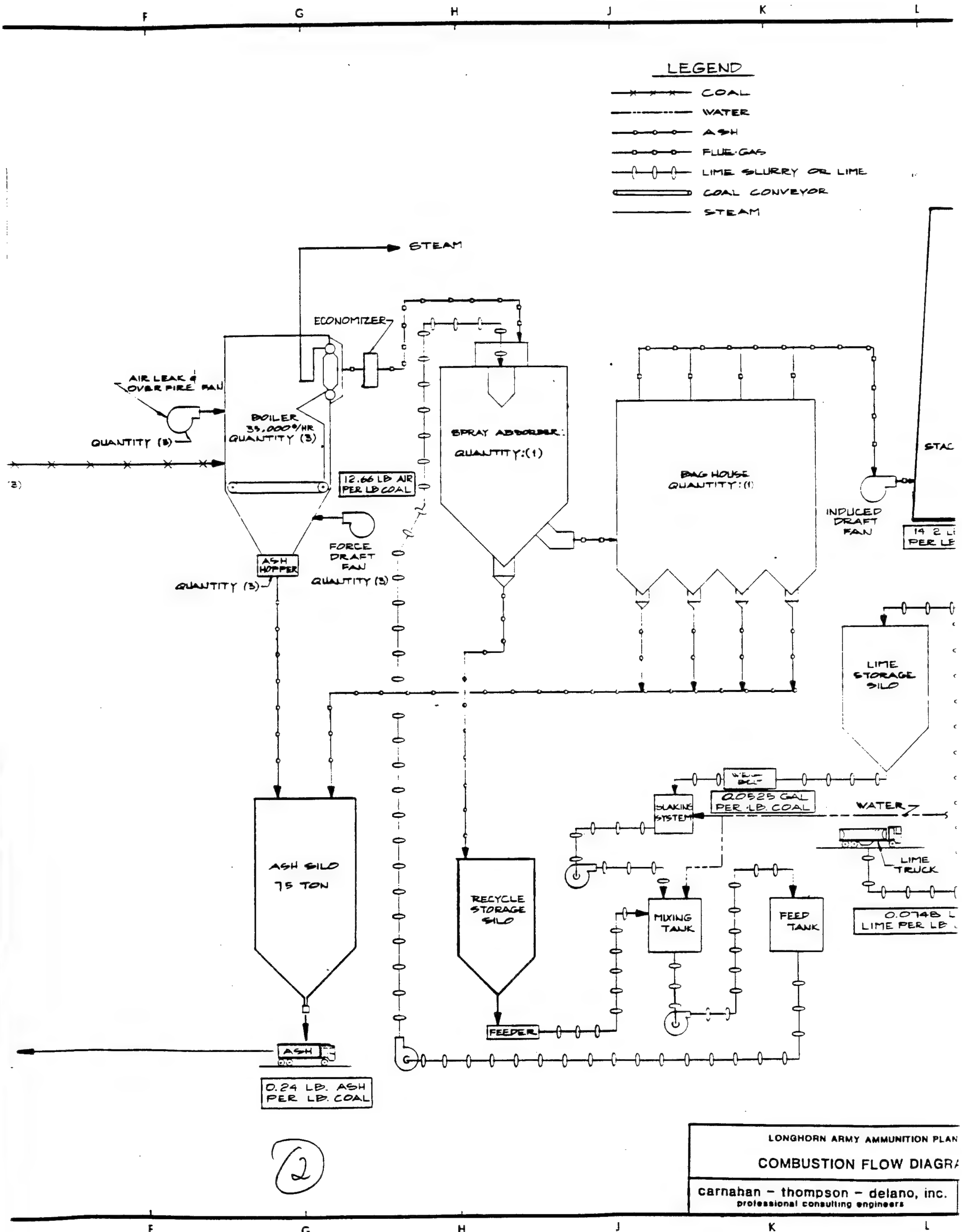


YEARLY AVERAGE COAL FIRING RATE				
SCHEME	PEACETIME		MOBILIZATION	
	LBS/HR	TONS/YR	LBS/HR	TONS/YR
B 165 PSIG/SAT	5,185	22,710	9,330	40,865




F
G
H
J
K
L
LEGEND
COAL
WATER
ASH
FLUE GAS
LIME SLURRY OR LIME
COAL CONVEYOR
STEAM
STEAM
ECONOMIZER
AIR LEAK & OVER FIRE FAN
BOILER 35,000#/HR QUANTITY (3)
QUANTITY (3)
12.66 LB AIR PER LB COAL
SPRAY ABSORBER QUANTITY: (1)
BAG HOUSE QUANTITY: (1)
STAC
INDUCED DRAFT FAN
14 2 L PER LE
FORCE DRAFT FAN QUANTITY (3)
ASH HOPPER
QUANTITY (3)
LIME STORAGE SILO
0.0525 GAL PER LB. COAL
WATER
SLAKING SYSTEM
LIME TRUCK
ASH SILO 75 TON
RECYCLE STORAGE SILO
MIXING TANK
FEED TANK
0.0748 L LIME PER LB
FEEDER
ASH
0.24 LB. ASH PER LB. COAL
2
LONGHORN ARMY AMMUNITION PLAN
COMBUSTION FLOW DIAGR
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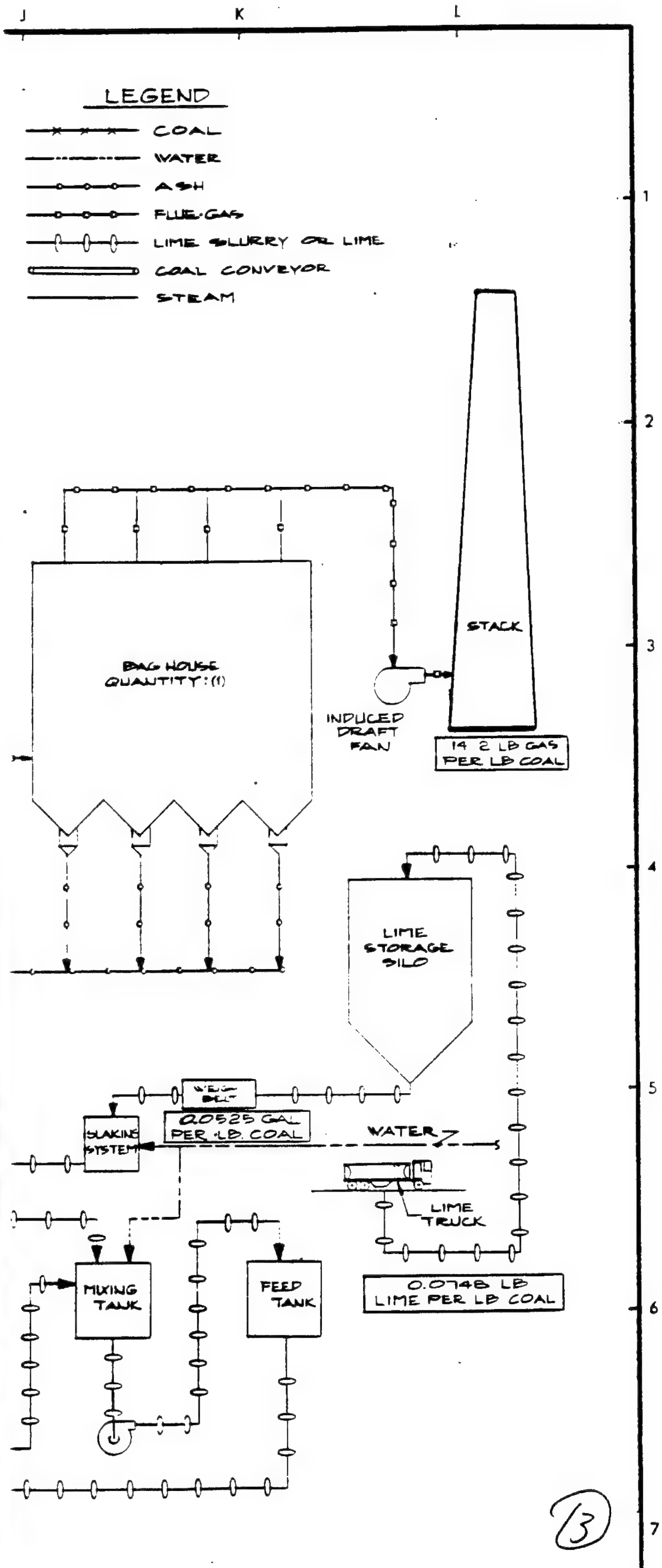
professional consulting engineers



LONGHORN ARMY AMMUNITION PLANT

COMBUSTION FLOW DIAGRAM

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	Dec., 1983	125

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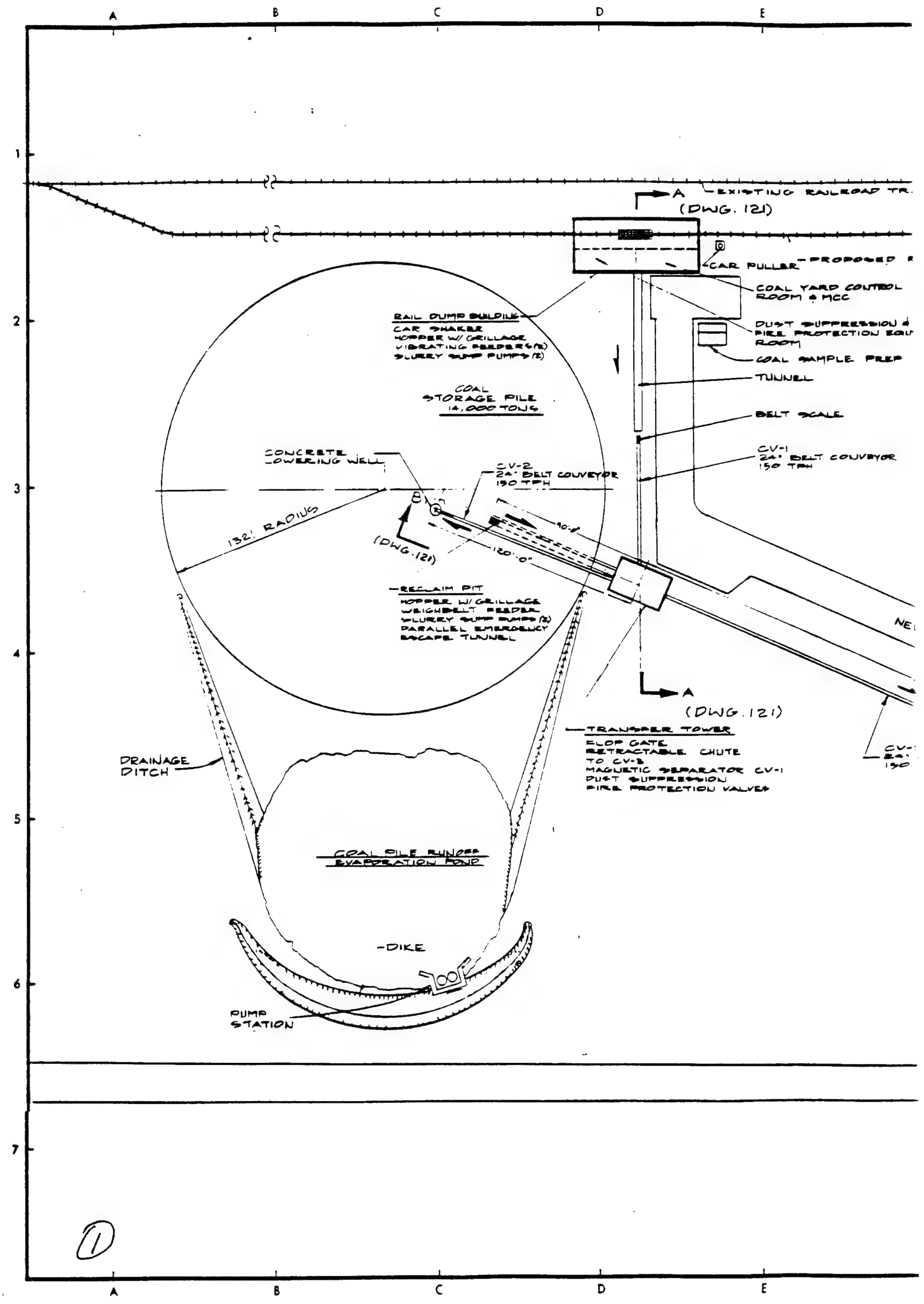
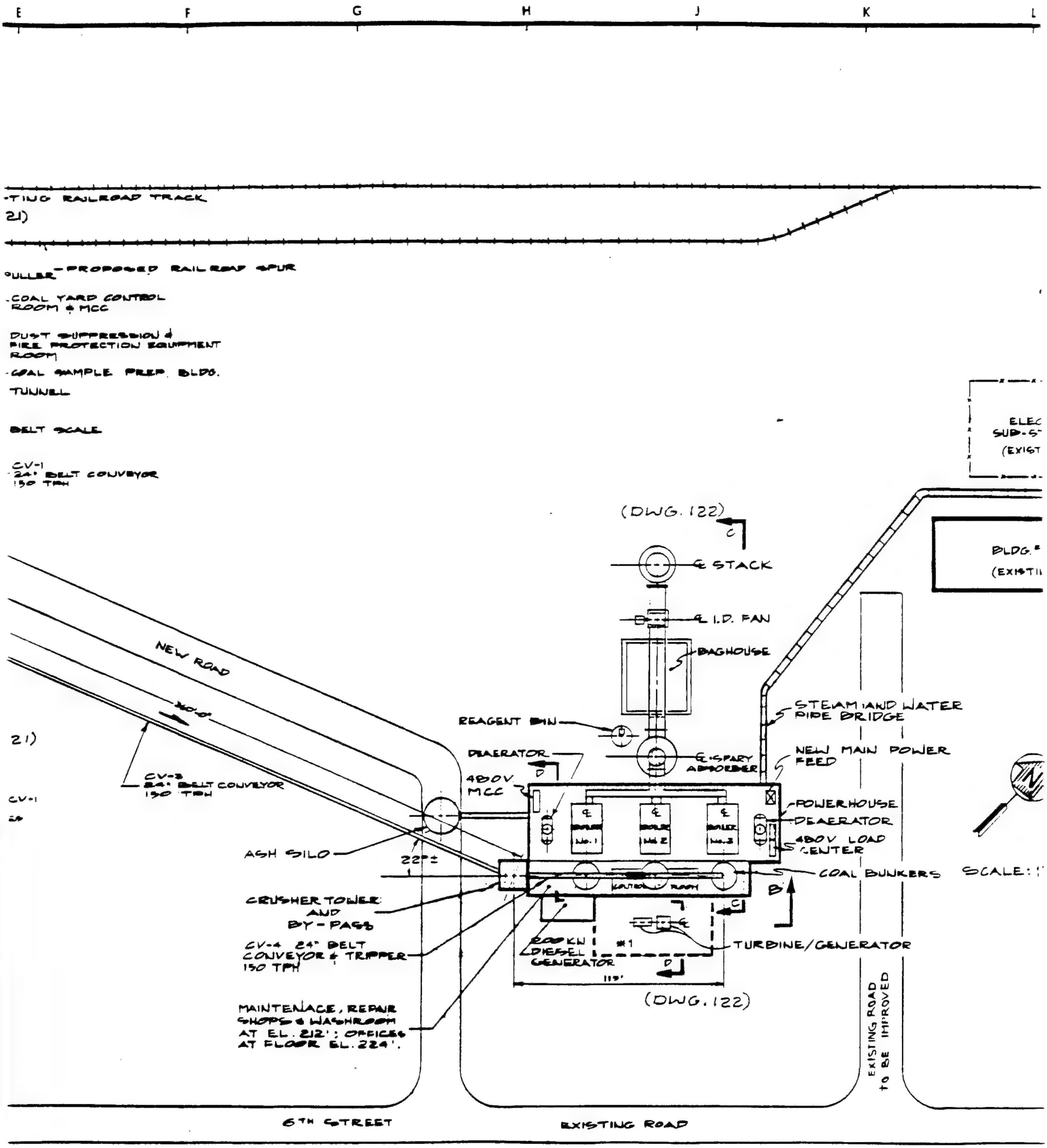

A
B
C
D
E
1
2
3
4
5
6
7
EXISTING RAILROAD TR.
A
(DWG. 121)
CAR PULLER
PROPOSED
COAL YARD CONTROL ROOM & MCC
DUST SUPPRESSION &
FIRE PROTECTION
ROOM
COAL SAMPLE PREP
TUNNEL
BELT SCALE
CV-1
24" BELT CONVEYOR
150 TPH
RAIL DUMP BUILDING
CAR SHAKER
HOPPER W/ GRILLAGE
VIBRATING FEEDERS (2)
SLURRY SUMP PUMPS (2)
COAL
STORAGE PILE
14,000 TONS
CONCRETE
LOWERING WELL
CV-2
24" BELT CONVEYOR
150 TPH
132' RADIUS
B
(DWG. 121)
90'-0"
120'-0"
RECLAIM PIT
HOPPER W/ GRILLAGE
WEIGHBELT FEEDER
SLURRY SUMP PUMPS (2)
PARALLEL EMERGENCY
ESCAPE TUNNEL
A
(DWG. 121)
TRANSFER TOWER
FLOP GATE
RETRACTABLE CHUTE
TO CV-3
MAGNETIC SEPARATOR CV-1
DUST SUPPRESSION
FIRE PROTECTION VALVES
DRAINAGE
DITCH
COAL PILE RUNOFF
EVAPORATION POND
DIKE
PUMP
STATION
1



* NOTES
1. T/G BLDG FOR SCHEME C, NOT REQ'D. FOR SCHEME B.

LONGHORN ARMY AMMUNITION
PROPOSED POWER HO
PLOT PLAN

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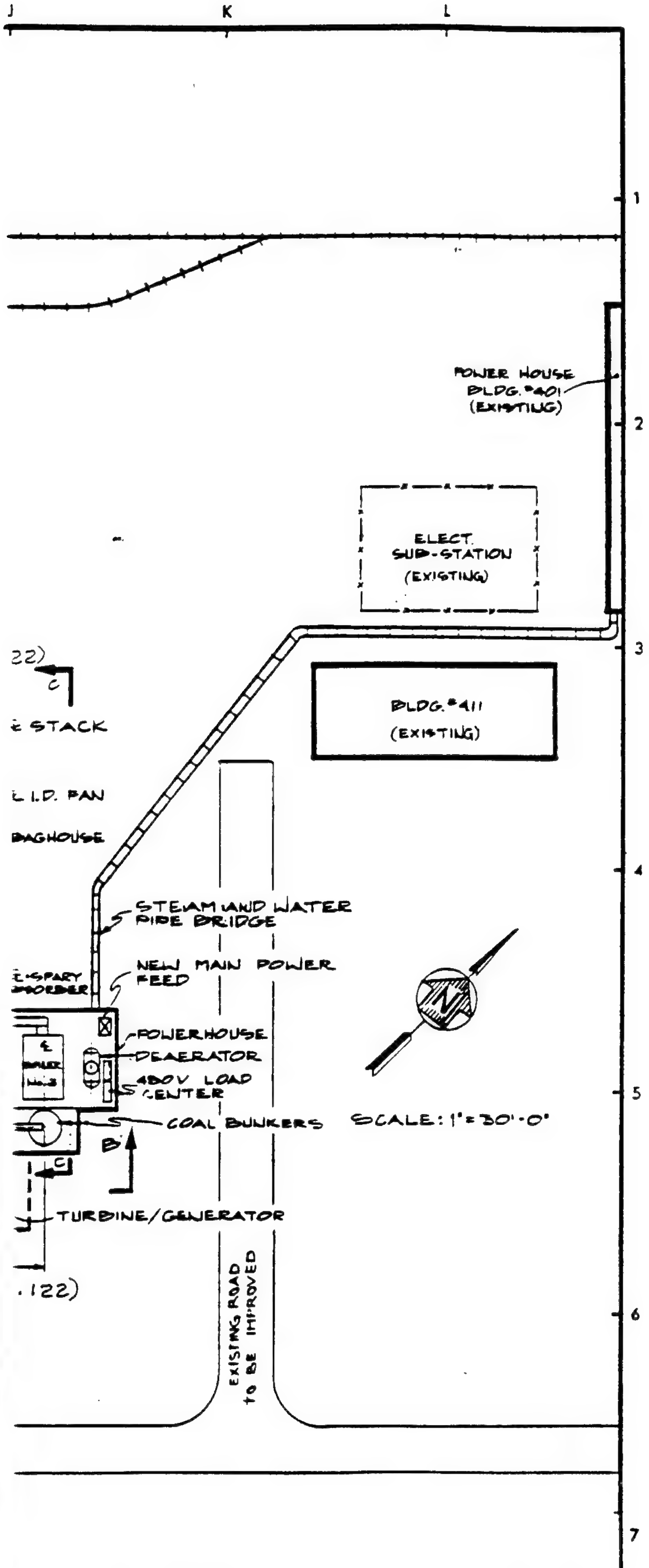
2

E F G H J K L



LONGHORN ARMY AMMUNITION PLANT

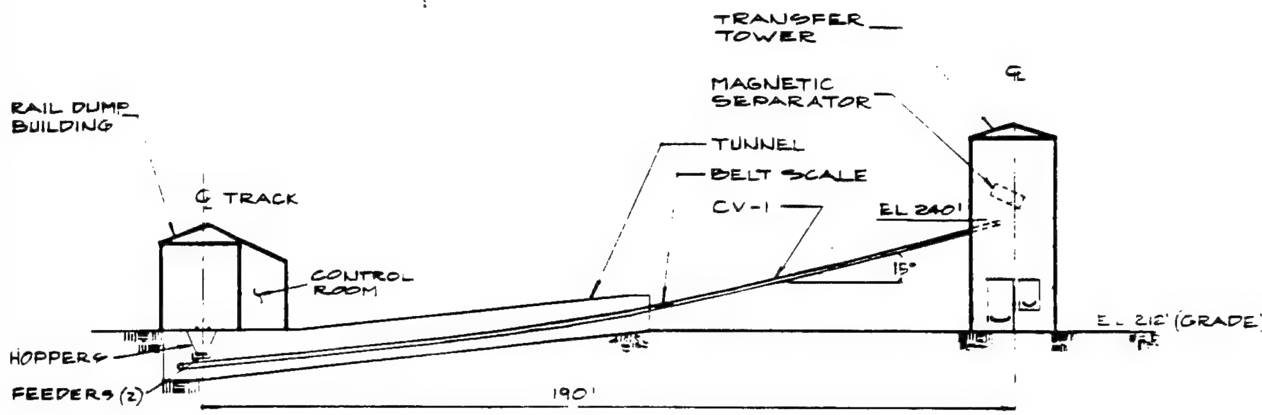
PROPOSED POWER HOUSE

PLOT PLAN

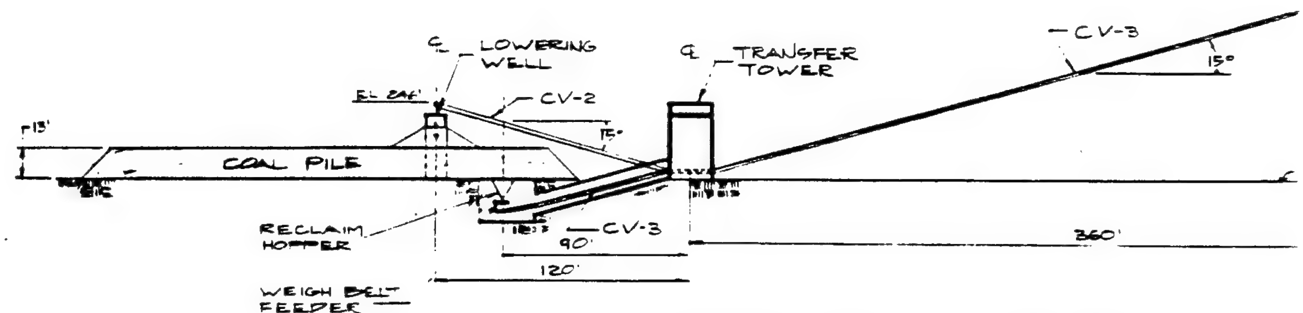
carnahan – thompson – delano, inc. professional consulting engineers	DATE DEC., 1988	DWG. NO 120

13

K L

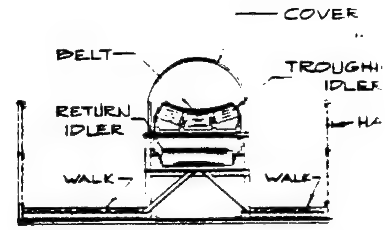


SECTION A-A (DWG. 120)
SCALE 1" = 20'

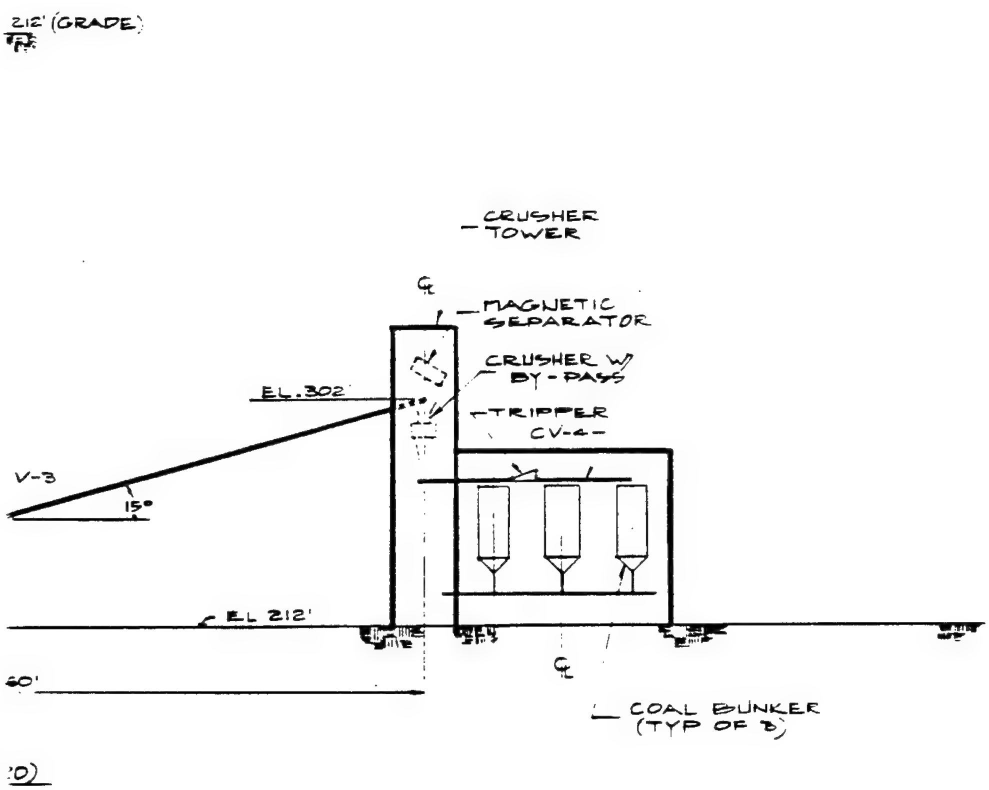


SECTION B-B (DWG. 120)
SCALE: 1" = 40'

1



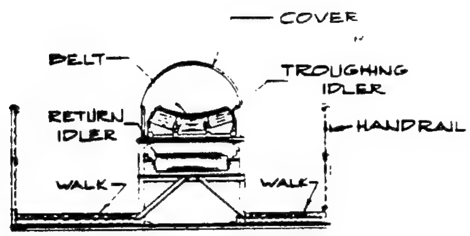
TYPICAL SECTION THR
COAL CONVEYOR ABOV
SCALE: 1/2" = 1'-0"



(2)

J K L

1



2

TYPICAL SECTION THRU COAL CONVEYOR ABOVE GRADE
SCALE: 1/2" = 1'-0"

3

4

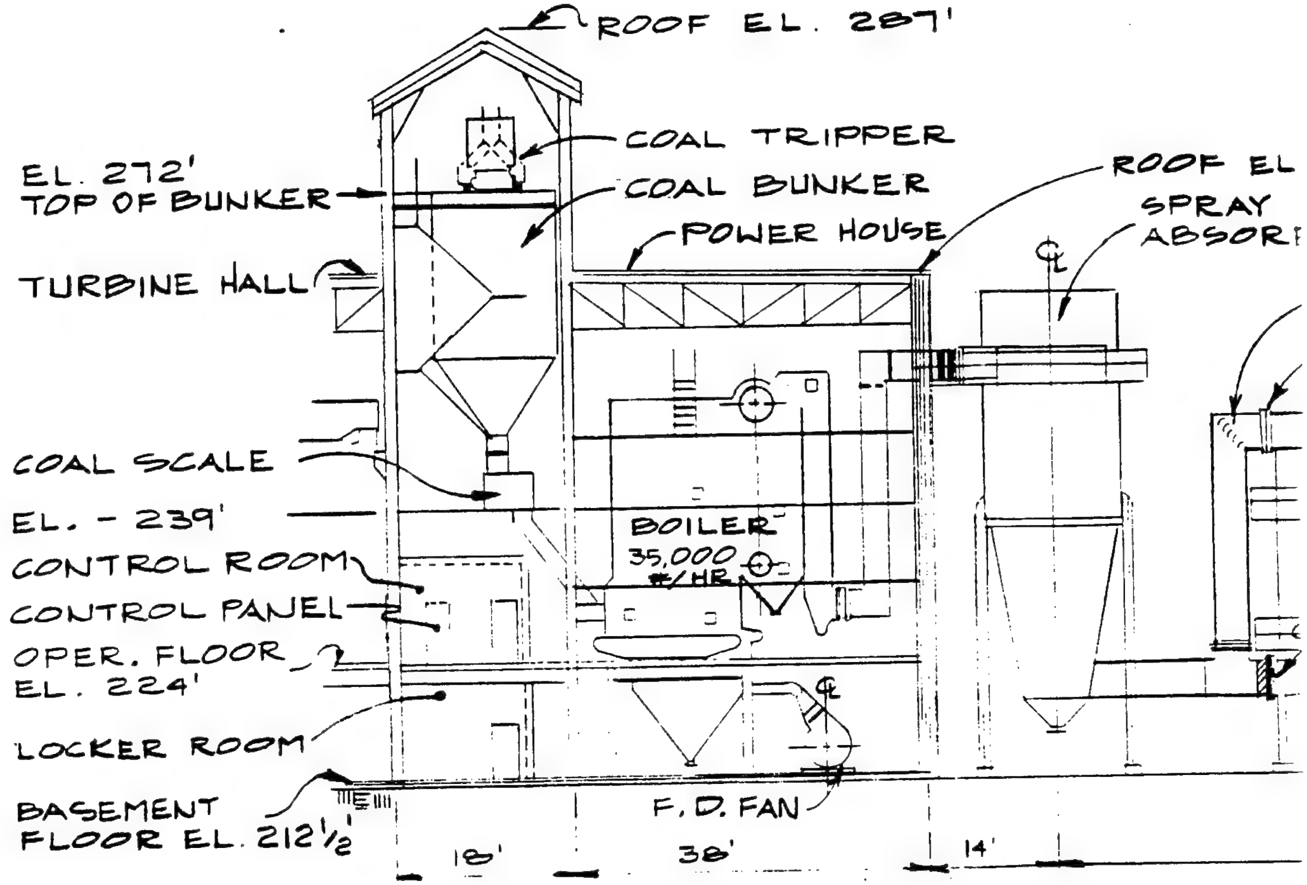
5

6

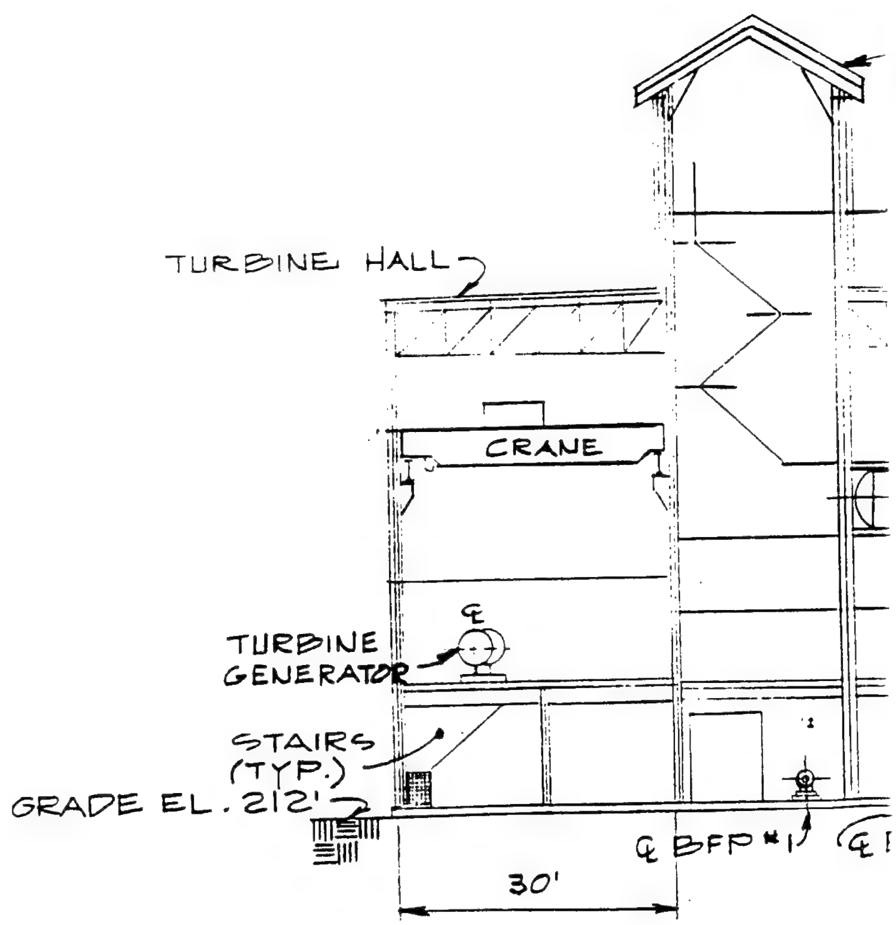
7

LONGHORN ARMY AMMUNITION PLANT PROPOSED POWER HOUSE SECTIONS & DETAILS		
carnahan – thompson – delano, inc. professional consulting engineers	DATE DEC. 1983	DWG. NO 121

13

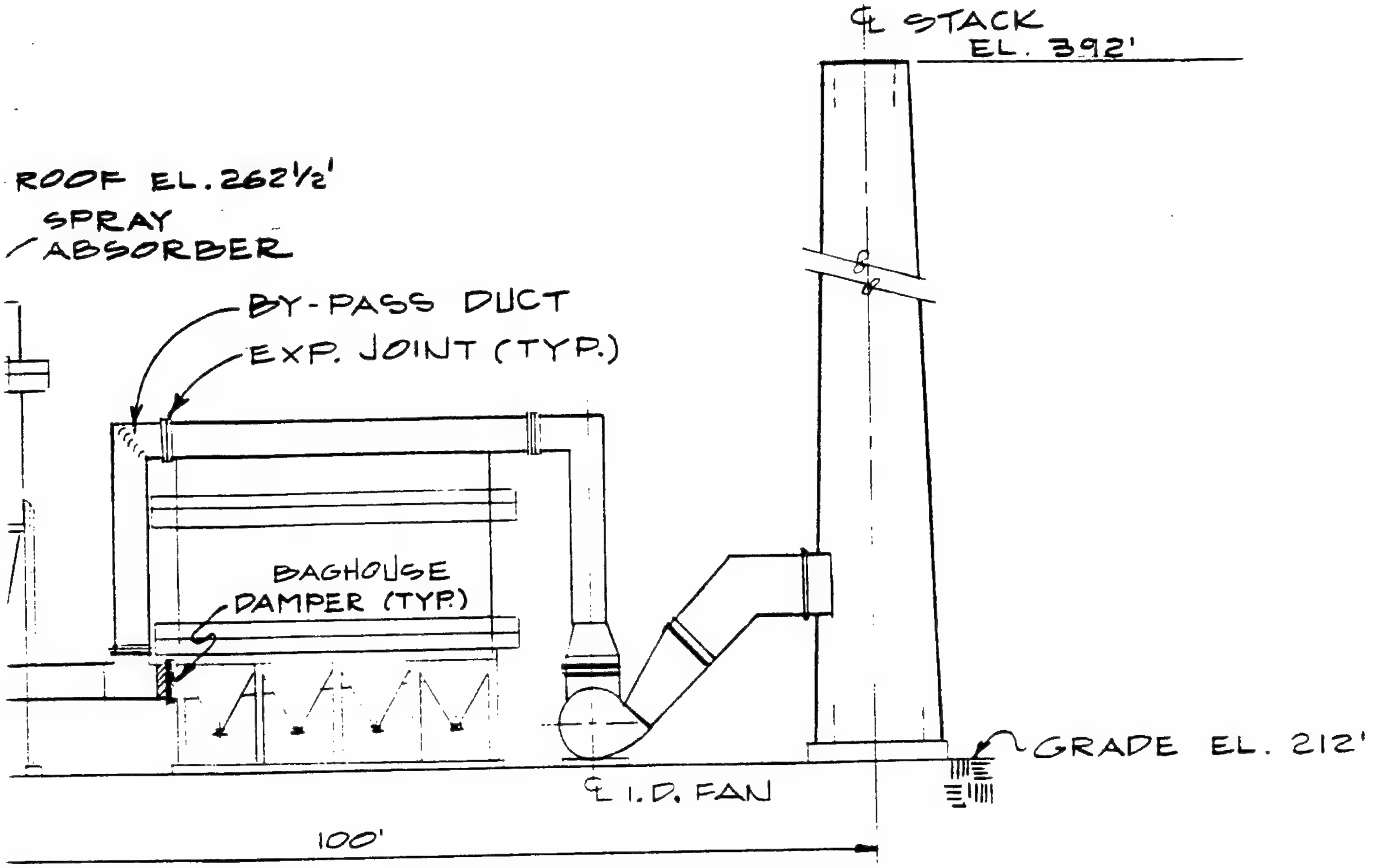


SECTION C

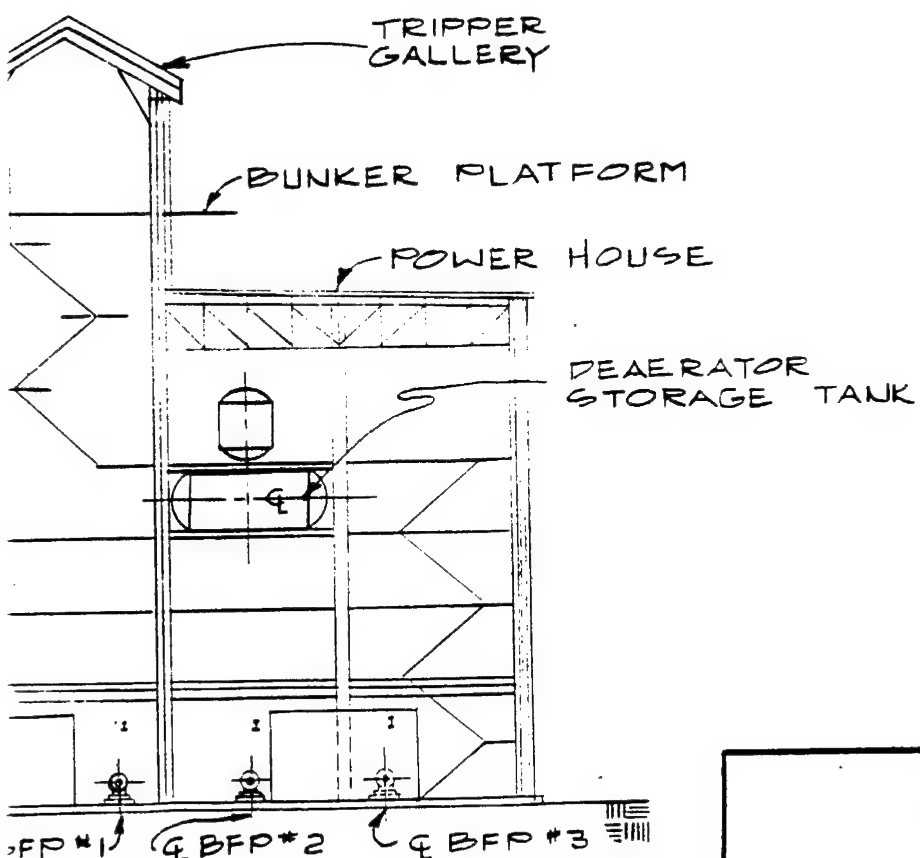


SECTION D

1



-ION C-C (DWG. № 120)



SCALE: 1" = 20'-0"

2

-TION D-D (DWG. № 120)

LONGHORN ARMY AMMUNITION PLANT
PROPOSED POWER HOUSE
SECTIONS C-C AND D-D

carnahan - thompson - delano, inc.
professional consulting engineers

DATE
DEC. 1983

ACK
EL. 392'

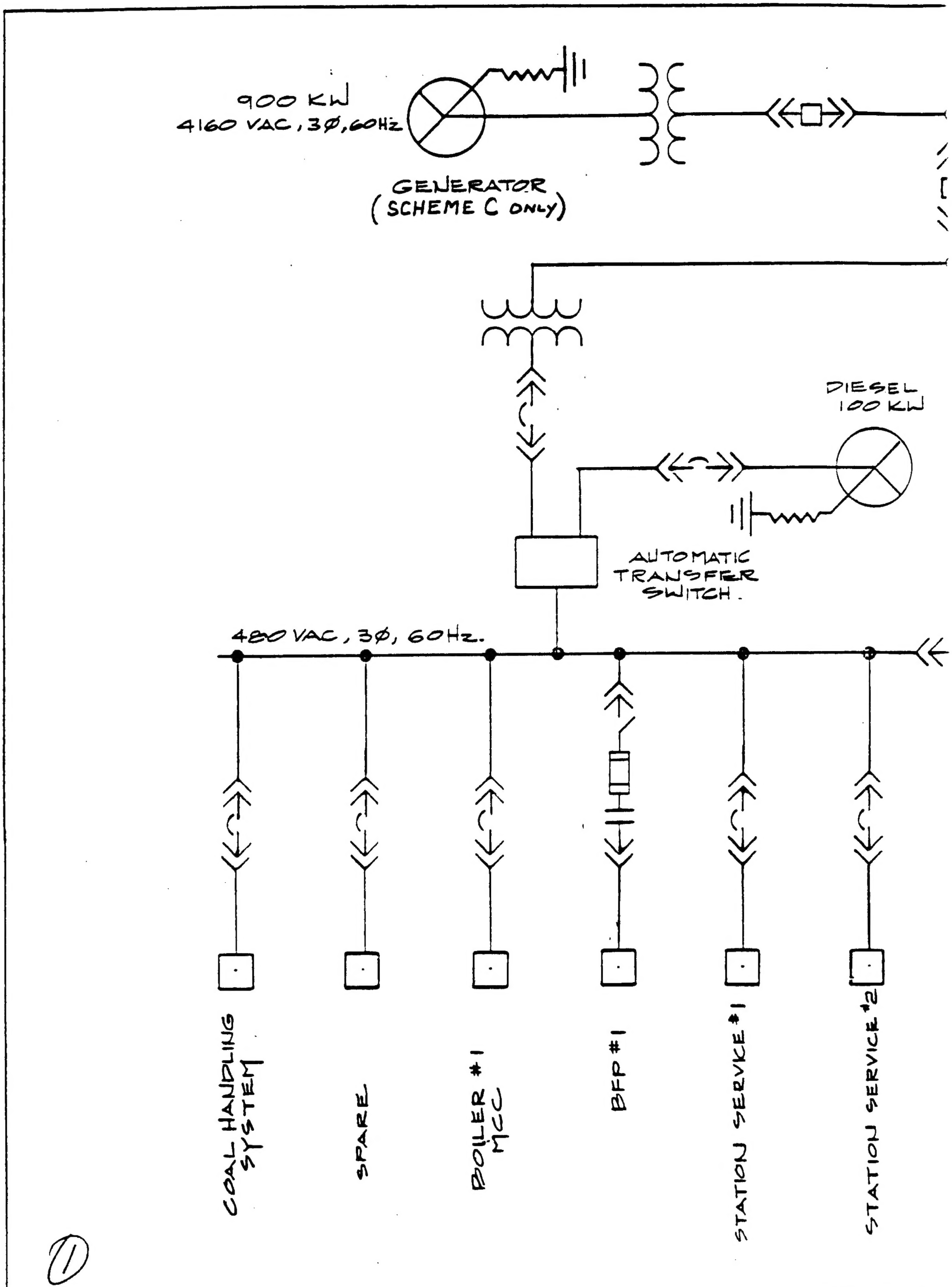
GRADE EL. 212'

SCALE: 1" = 20'-0"

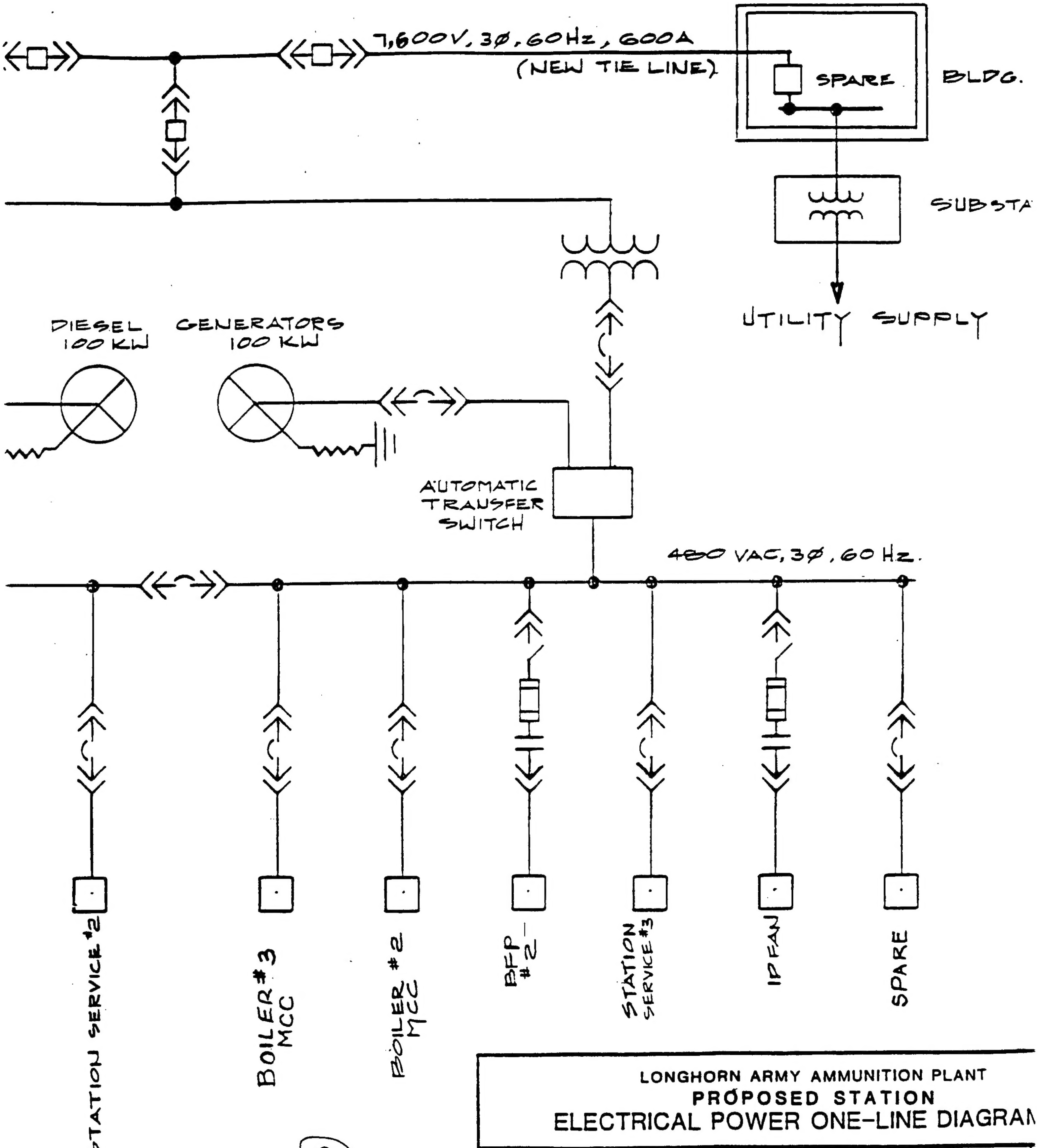
ORN ARMY AMMUNITION PLANT
POSED POWER HOUSE
SECTIONS C-C AND D-D

(3)

	DATE	DWG. NO
ompson – delano, inc. l consulting engineers	DEC. 1983	122



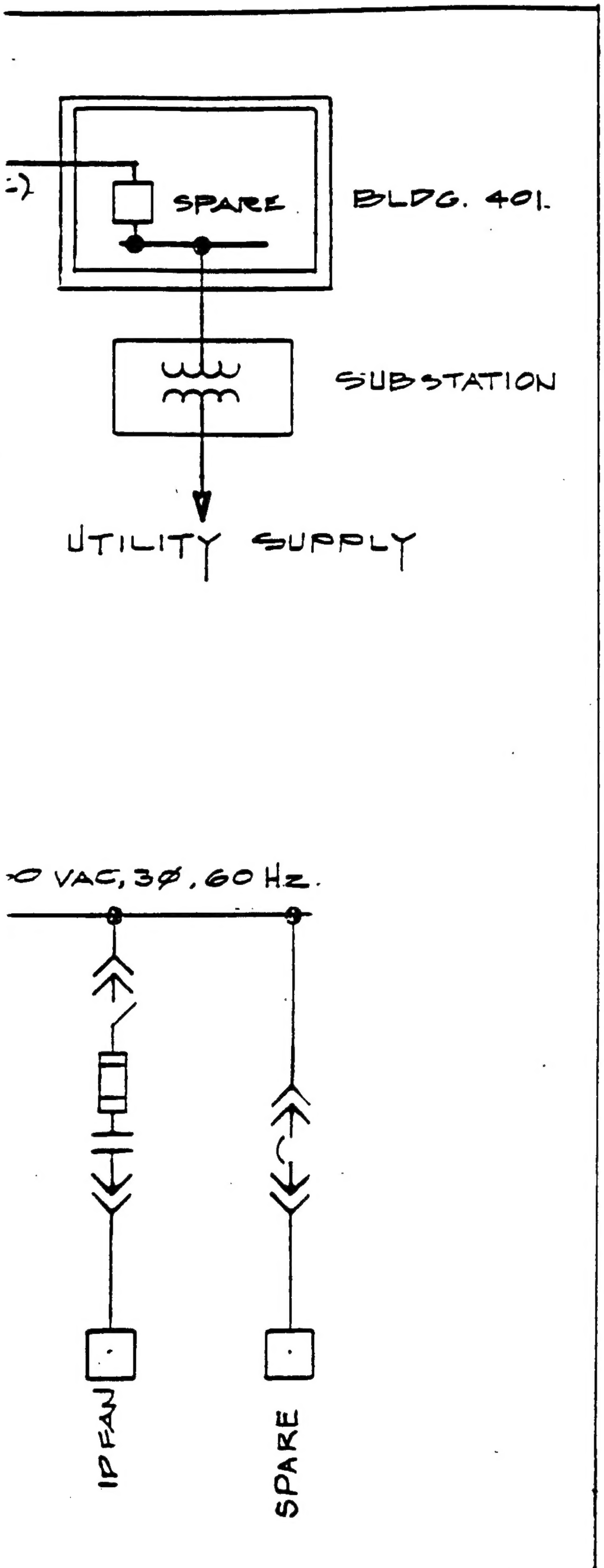
900 KW
4160 VAC, 3Ø, 60Hz
GENERATOR
(SCHEME C ONLY)
DIESEL
100 KW
AUTOMATIC
TRANSFER
SWITCH.
480 VAC, 3Ø, 60Hz.
COAL HANDLING
SYSTEM
SPARE
BOILER #1
MCC
BFP #1
STATION SERVICE #1
STATION SERVICE #2
1



LONGHORN ARMY AMMUNITION PLANT
PROPOSED STATION
ELECTRICAL POWER ONE-LINE DIAGRAM

carnahan – thompson – delano, inc. professional consulting engineers	DATE DEC., 1983

(2)



ORN ARMY AMMUNITION PLANT
RÓPOSED STATION
POWER ONE-LINE DIAGRAM

3

ɔson – delano, inc. ısulting engineers	DATE DEC., 1983	DWG. NO 130

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